FYUG SYLLABUS

ECOLOGY AND ENVIRONMENTAL SCIENCE
(SEMESTER 1-SEMESTER VIII)

ASSAM UNIVERSITY, SILCHAR

COURSE OUTLINE

Semester	Course category, marks and credit	Course title	Unit names
I	**Discipline Specific Core (DSC-101)** Total Marks= 100 End Semester Examination= 70 Internal Examination = 30 **Total Credits=3**	ECOLOGY AND ECOSYSTEMS	Basic concepts of ecology Ecology of populations Ecology of communities Ecosystem ecology Biogeochemical cycles and nutrient cycling
	Discipline Specific Core (DSC-102) Total Marks= 100 End Semester Examination = 70 Internal Examination = 30 **Total Credits=3**	EARTH AND EARTH SURFACE PROCESSES	History of Earth Earth system processes Minerals and rocks Earth surface processes Importance of being a mountain
	Discipline Specific Minor (DSM-101) Total Marks= 100 End Semester Examination = 70 Internal Examination = 30 **Total Credits=3**	FUNDAMENTALS OF ECOLOGY	Concepts of ecology Population ecology Community ecology Ecosystem ecology Biogeochemical cycles
	Interdisciplinary Course (IDC101) Total Marks= I 00 End Semester Examination = 70 Internal Examination= 30 **Total Credits=3**	BASIC CONCEPTS OF ECOLOGY AND ENVIRONMENTAL SCIENCE	Introduction to Ecology and Environmental Science Ecosystem and its components Atmosphere Hydrosphere Lithosphere
	Skill Enhancement Course (SEC-101) Total Marks= 100 End Semester Examination = 50 Practical Examination = 30 Internal Test= 20 **Total Credits=3**	BAMBOO CULTIVATION, UTILIZATION AND MANAGEMENT	Diversity, Distribution and Growth behaviour Silvicultural management Propagation and Nursery Management Bamboo as food Bamboo products and value addition
II	**Discipline Specific Core (DSC-151)** Total Marks= 100 End Semester Examination = 70 Internal Examination = 30 **Total Credits=3**	PHYSICS AND CHEMISTRY OF THEENVIRONMENT	Fundamentals of environmental physics Fundamentals of environmental chemistry Atmospheric chemistry Water chemistry Soil chemistry
	Discipline Specific Core (DSC-152) Total Marks= 100 End Semester Examination = 70 Internal Examination = 30 **Total Credits=3**	ECOSYSTEMS, EARTH SURFACE, PHYSICS AND CHEMISTRY OF THE ENVIRONMENT (PRACTICAL)	
	Discipline Specific Minor (DSM-151)	BASIC CONCEPTS OF ECOLOGY	Ecological concepts Ecology of populations

	Total Marks= 100 End Semester Examination = 70 Internal Examination= 30 **Total Credits=3**		Ecology of communities Ecosystem structure and function Biogeochemical cycles
	Interdisciplinary Course (IDC 151) Total Marks= 100 End Semester Examination = 70 Internal Examination = 30 **Total Credits=3**	NATURAL RESOURCES, BIODIVERSITY CONSERVATION AND ENVIRONMENTAL POLLUTION	Natural Resources Biodiversity and conservation Environmental Pollution Major environmental issues Urbanization and environment
	Skill Enhancement Course (SEC-151) Total Marks= 100 End Semester Examination = 50 Practical Examination = 30 Internal Test = 20 **Total Credits=3**	ENVIRONMENTAL IMPACT AND RISK ASSESSMENT	Concept of EIA Components and role of EIA EIA and Environmental management EIA regulations Risk assessment
	Common Value Added Course (VAC-151) Total Marks= 100 End Semester Examination = 70 Internal Examination = 30 **Total Credits=3**	ENVIRONMENTAL STUDIES	Introduction to Environmental Studies Natural Resources and Management Biodiversity and conservation Environmental pollution and climate change Environmental ethics and disaster management

Discipline Specific Core (DSC- 101)

ECOLOGY ANDECOSYSTEMS

Total Marks= 100

End Semester Examination = 70

Internal Examination= 30

Total Credits=3

Unit 1: Basic concepts of ecology: (10 lectures)

Definitions: ecology, landscape, habitat, ecozones, biosphere, ecosystems, ecosystem stability, resistance and resilience; autecology; synecology; major terrestrial biomes; ecological amplitude; Liebig's Law of the Minimum; Shelford's Law of Tolerance; phenotypic plasticity; ecotypes; ecoclines; ecological niche.

Unit 2: Ecology of populations: (10 lectures)

Concept of population and meta-population; r- and K-selection; characteristics of population: density, dispersion, natality, mortality, life tables, survivorship curves, age structure; population growth: geometric, exponential, logistic, density-dependent; limits to population growth.

Unit 3: Ecology of communities: **(10 lectures)**

Community structure and organization; keystone species; ecotone and edge effect; species diversity; species interactions (positive and negative); ecological succession and climax community.

Unit 4: Ecosystem ecology: (10 lectures)

Types of ecosystem: forest, grassland, lentic, lotic, estuarine, marine, desert, wetlands; ecosystem structure and function; abiotic and biotic components of ecosystem; food chain, foodweb; ecological efficiencies; ecological pyramids.

Unit 5: Biogeochemical cycles and nutrient cycling: (10 lectures)

Carbon cycle; nitrogen cycle; phosphorus cycle; sulphur cycle; hydrological cycle; nutrient cycling; input of nutrients in ecosystem; biotic accumulation; nutrient supply and uptake.

Suggested Readings

I. Groom. B. & Jenkins. M. (2000). Global Biodiversity: Earth's Living Resources in the 21st Century. World Conservation Press, Cambridge, UK.

2. Gurevitch, J., Scheiner, S. M., & Fox, G. A. (2002). The Ecology of Plants. Sinauer associates incorporated.

3. Loreau, M. & lnchausti, P. (2002). Biodiversity and Ecosystem Functioning: Synthesis and Perspectives. Oxford University Press, Oxford, UK.

4. Odum, E.P. (1971). Fundamentals of Ecology. W.B. Sounders.

5. Pimentel, D. (Ed.) 2011. Biological invasions: Economic and environmental costs of alien plant, animal, and microbe species. CRC Press.

6. Singh, J.S., Singh, S.P. & Gupta, S.R. (2006). Ecology, Environment and Resource Conservation. Anamaya Publications.

7. Wilson, E. 0. (1985). The Biological Diversity Crisis. Bio Science 35: 700-706.

Discipline Specific Core (DSC- I 02)

EARTH AND EARTH SURFACE PROCESSES

Total Marks= 100

End Semester Examination = 70

Internal Examination= 30

Total Credits=3

Unit 1: History of Earth: (10 lectures)

Formation of the Earth: formation and composition of core, mantle, crust, atmosphere and hydrosphere; chemical composition of Earth; geological time scale and major changes on the Earth's surface; Holocene and the emergence of humans.

Unit 2: Earth system processes: (10 lectures)

Movement of lithosphere plates; mantle convection and plate tectonics, major plates and geological hot spots, plate boundaries; sea floor spread; earthquakes; volcanic activities; orogeny; isostasy; gravitational and magnetic fields of the earth; origin of the main geomagnetic field; continental drift, Pangaea and present-day continents.

Unit 3: Minerals and rocks: (10 lectures)

Minerals and important rock forming minerals; rock cycle: lithification and metamorphism; Three rock laws; rock structure, igneous, sedimentary and metamorphic rocks; weathering: physical, biogeochemical processes; erosion: physical processes of erosion, factors affecting erosion.

Unit 4: Earth surface processes: (10 lectures)

Atmosphere: Composition of atmosphere, physical and optical properties, circulation; interfaces: atmosphere-ocean interface, atmosphere-land interface, ocean-land interface, rivers and geomorphology; types of glaciers, glacier dynamics.

Unit 5: Importance of being a mountain: (10 lectures)

Formation of Peninsular Indian mountain systems - Western and Eastern Ghats, Vindhyas, Aravallis, etc. Formation of the Himalaya; development of glaciers, perennial river systems, formation of the Indo-Gangetic Plains.

Suggested Readings

I. Bridge, J., & Demicco, R. (2008). Earth Surface Processes, Landforms and Sediment deposits. Cambridge University Press.

2. Duff, P. M. D., & Duff, D. (Eds.). 1993. Holmes' Principles of physical Geology. Taylor & Francis.

3. Gupta, A. K., Anderson, D. M., & Overpeck, J. T. (2003). Abrupt changes in the Asian southwest monsoon during the Holocene and their links to the North Atlantic Ocean. Nature 421:354-357.

4. Gupta, A. K., Anderson, D. M., Pandey, D. N., & Singhvi, A. K. (2006). Adaptation and human migration, and evidence of agriculture coincident with changes in the Indian summer monsoon during the Holocene. Current Science 90: 1082-1090.

5. Keller, E.A.(2011). Introduction to Environmental Geology (5th edition). Pearson Prentice Hall.

6. Krishnan, M. S. (1982). Geology of India and Burma. CBS Publishers & Distributors.

7. Leeder, M., Arlucea, M.P. (2005). Physical Processes in Earth and Environmental Sciences. Blackwell Publishing.

8. Pelletier, J. D. (2008). Quantitative Modeling of Earth Surface Processes (Vol. 304). Cambridge: Cambridge University Press. Chicago.

Discipline Specific Minor (DSM-101)

FUNDAMENTALS OF ECOLOGY

Total Marks= 100

End Semester Examination = 70

Internal Examination= 30

Total Credits=3

Unit 1: Concepts of ecology: (10 lectures)

Basic concepts and definitions: ecology, landscape, habitat, ecozones, biosphere, ecosystems, ecosystem stability, resistance and resilience; autecology; synecology; major terrestrial biomes; Liebig's Law of the Minimum; Shelford's Law of Tolerance; ecological niche.

Unit 2: Population ecology: (10 lectures)

Concept of population and meta-population; r- and K-selection; characteristics of population: density, dispersion, natality, mortality, life tables, survivorship curves, age structure; population growth: geometric, exponential, logistic, density-dependent.

Unit 3: Community ecology: (10 lectures)

Community structure and organization: keystone species, ecotone and edge effect; species interactions: positive and negative; ecological succession and climax community.

Unit 4: Ecosystem ecology: (10 lectures)

Types of ecosystem: forest, grassland, lentic, lotic, estuarine, marine, desert, wetlands; ecosystem structure and function; abiotic and biotic components of ecosystem; food chain, food web; ecological pyramids.

Unit 5: Biogeochemical cycles: (10 lectures)

Carbon cycle; nitrogen cycle; phosphorus cycle; sulphur cycle; hydrological cycle; ecosystem input of nutrients; nutrient supply and uptake.

Suggested Readings

I. Groom. B. & Jenkins. M. (2000). Global Biodiversity: Earth's Living Resources in the 2lst Century. World Conservation Press, Cambridge, UK.

2. Gurevitch, J., Scheiner, S. M., & Fox, G. A. (2002). The Ecology of Plants. Sinauer associates incorporated.

3. Loreau, M. & Inchausti, P. (2002). Biodiversity and Ecosystem functioning: Synthesis and Perspectives. Oxford University Press, Oxford, UK.

4. Odum, E.P. 1971. Fundamentals of Ecology. W.B. Sounders.

5. Pandit, M.K., White, S.M.& Pocock, M.J.O. (2014). The contrasting effects of genome size, chromosome number and ploidy level on plant invasiveness: a global analysis. New Phytologist 203: 697-703.

6. Pimentel, D. (Ed.). 201 I. Biological invasions: Economic and environmental costs of alien plant, animal, and microbe species. CRC Press.

7. Singh, J.S., Singh, S.P. & Gupta, S.R. (2006). Ecology, Environment and Resource Conservation. Anamaya Publications.

8. Wilson, E. O. (1985). The Biological Diversity Crisis. Bio Science 35:700-706.

SEMESTER-I

Interdisciplinary Course (IDC - 101)

Name of the paper: Basic Concepts of Ecology and Environmental Science

Total Marks= 100

End Semester Examination = 70

Internal Examination= 30

Total Credits=3

UNITI: Introduction to Ecology and Environmental Science: **(10 lectures)**

Definition, aim, Objectives, scope and importance of Ecology and Environmental Science; history of ecology; various approaches of studying Ecology and Environmental Science; multidisciplinary nature of Ecology and Environmental Science; Need for environmental awareness.

UNIT 2: Ecosystem and its components: **(12 lectures)**

Concept and definition of ecosystem; components of ecosystem; types of ecosystem: terrestrial ecosystem, aquatic ecosystem; concept of species, population and community; energy flow in an ecosystem; food chain and food web; biogeochemical cycle: patterns and types; biosphere.

UNIT 3: Atmosphere: **(8 lectures)**

Definition, composition and importance of atmosphere; layers of atmosphere; stratospheric ozone; differences between weather and climate; climate of North East India; tropical monsoon climate.

UNIT 4: Hydrosphere: **(10 lectures)**

Definition and importance of the hydrosphere; hydrologic cycle; fresh water ecosystem (lotic and lentic); marine ecosystem; estuarine ecosystem. Concept: Surface and ground water.

UNIT 5: Lithosphere: **(10 lectures)**

Definition, composition and importance of lithosphere; formation and composition of core, mantle and crust. Composition and formation of soil; physical properties of soil; soil profile; soil water holding capacity; soil humus.

Suggested readings:

I. Asthana, D. K. (2006). Text Book of Environmental Studies. S. Chand Publishing.

2. Basu, M., Xavier, S. (2016). Fundamentals of Environmental Studies, Cambridge University Press, India.

3. Bharucha, E. (2013). Textbook of Environmental Studies for Undergraduate Courses. Universities Press.

4. De, A.K., (2006). Environmental Chemistry, 6th Edition, New Age International, New Delhi.

5. Odum, E. P., Odum, H. T., & Andrews, J. (I 971). Fundamentals of ecology. Philadelphia: Saunders.

6. Sharma, P. D., & Sharma, P. D. (2005). Ecology and environment. Rastogi Publications.

7. Sharma, P. D., & Sharma, P. D. (2005). Ecology and environment. Rastogi Publications.

8. Odum, E.P., Odum, H.T. & Andrews, J. (1971). Fundamentals of Ecology. Philadelphia: Saunders.

9. Killham, K. (1994). Soil Ecology. Cambridge University Press.

Abe

Skill Enhancement Course (SEC- 101)

BAMBOO CULTIVATION, UTILIZATION AND MANAGEMENT

Total Marks= 100

End Semester Examination= 50

Practical Examination= 30

Internal Test = 20

Total Credits=3

Unit 1: Diversity, Distribution and Growth behaviour: (10 lectures)

Origin, diversity and distribution of bamboo in the global scenario with special reference to Northeast India, Rhizome types, Clump and culm character, Culm sheath, Culm emergence, Culm elongation, Shoot mortality, Branching habit, Culm production.

Unit 2: Silvicultural management: (10 lectures)

Plantation raising and silvicultural management, harvesting strategies of forest and village bamboos, Nutrient and fertilizer management in bamboos; Insect pests and diseases of bamboo and their control.

Unit 3: Propagation and Nursery Management: (10 lectures)

Rhizome, culm and branch cutting, culm cutting and layering. Concept of tissue culture, Infrastructure facilities, Concept of green house, net house, polyhouse and their utility. Nursery bed preparation, techniques of nursery management, seedling nursing and management, Vegetative Propagation Centre.

Unit 4: Bamboo as food: (10 lectures)

Bamboo shoots and human health, Indigenous and oriental recipes, Nutritional properties of bamboo shoot, Processing technology for storage of fresh bamboo shoots, Preservation techniques, Traditional and laboratory fermentation techniques of bamboo shoots.

Unit 5: Bamboo products and value addition: (10 lectures)

Traditional and commercial utilization of bamboos, utilization of bamboo resources for: traditional and value added craft, incense stick and paper industry.

Practicals:

1. Studying rhizome behaviour in bamboos - sympodial, amphipodial and monopodial.
2. Studying culm ages in a bamboo.
3. Documenting traditional uses of bamboo products.
4. Bamboo propagation through offset, culm cutting and branch cutting.
5. Tutorial work to be given to students based on the theory paper.

Suggested readings:

1. Banik, R.L. (1995. A Manual for Vegetative Propagation of Bamboos. INBAR.

2. Banik, R.L. (2000). Silviculture and Field-Guide to Priority Bamboos of Bangladesh and South Asia. Government of the people's republic of Bangladesh, Bangladesh Forest research Institute, Chittagong.
3. Banik, R.L. (2010). Biology and silviculture of Muli Bamboo *(Melocanna baccifera)*.National Mission on Bamboo Applications, New Delhi.
4. Barooah, C. and Bortakur, S.K. (2003). Diversity and Distribution of Bamboos in Assam.Bishen Singh Mahendra Pal Singh.
5. Bedell, P.E. (1997). Taxonomy of Bamboos. APC Publications Pvt. Ltd.
6. FAO (2010). Global Forest Resources Assessment, 2010. Food and Agricultural Organisation.
7. FSI (2011). India State of Forest Report. Forest Survey oflndia, Dehradun.
8. Liese, W. And Kohl, M. (2015). Bamboo: The Plant and its Uses (Tropical Forestry). Springer International Publishing.
9. NMBA (2004). The Bamboo Book. National Mission on Bamboo Applications. Department of Science and Technology, New Delhi.
10. Negi, S.S. (2009). Bamboos of India. Bishen Singh Mahendra Pal Singh.
11. Seethalakshmi, K.K. and Muktesh Kumar, M.S. (1998). Bamboos of India: A compendium. Kerala Forest Research Institute &INBAR.
12. Tewari, D.N. (1992). A Monograph on Bamboo. International Book Distributors.

Discipline Specific Core (DSC-151)

PHYSICS AND CHEMISTRY OF THE ENVIRONMENT

Total Marks= 100

End Semester Examination = 70

Internal Examination= 30

Total Credits=3

Unit 1: Fundamentals of environmental physics: (12 lectures)

Basic concepts of light and matter; quantum mechanics (relation between energy, wavelength and frequency), black body radiation, spectroscopic concepts: Introduction to the concept of absorption and transmission of light, Beer-Lambert law. Basic concepts of pressure, force, work and energy; laws of thermodynamics.

Unit 2: Fundamentals of environmental chemistry: (12 lectures)

Atomic structure, electronic configuration, periodic properties of elements (ionization potential, electron affinity and electronegativity), types of chemical bonds (ionic, covalent, coordinate and hydrogen bonds); mole concept, molarity and normality, acids, bases and salts, solubility products; solutes and solvents; redox reactions, concepts of pH and pE.

Unit 3: Atmospheric chemistry: (10 lectures)

Composition of atmosphere; photochemical reactions in atmosphere; smog formation, types of smog (sulphur smog and photochemical smog), aerosols; acid rain, reactions of NO2 and SO2; free radicals and ozone layer depletion, role of CFCs in ozone depletion.

Unit 4: Water chemistry: (10 lectures)

Chemical and physical properties of water; alkalinity and acidity of water, hardness of water, calculation of total hardness; solubility of metals, complex formation and chelation; colloidal particles; heavy metals in water.

Unit 5: Soil chemistry: (10 lectures)

Soil composition; relation between organic carbon and organic matter, inorganic and organic components in soil; soil humus; cation and anion exchange reactions in soil; nitrogen, phosphorus and potassium in soil; phenolic compounds in soil.

Suggested Readings:

1. Beard, J.M. (2013). Environmental Chemistry in Society (2ndedition). CRC Press.
2. Boeker, E. & Grondelle, R. 2011. Environmental Physics: Sustainable Energy and Climate Change. Wiley.
3. Connell, D.W. (2005). Basic Concepts of Environmental Chemistry (2ndedition). CRC Press.
4. Forinash, K. (2010). Foundation of Environmental Physics. Island Press.
5. Girard, J. (2013). Principles of Environmental Chemistry (3rd edition). Jones & Bartlett.
6. Hamung, S.E. & Johnson, M.S. (2012). Chemistry and the Environment. Cambridge University Press.
7. Hites, R.A. (2012). Elements of Environmental Chemistry (2nd edition). Wiley & Sons.
8. Manhan, S. E. (2000). Fundamentals of Environmental Chemistry. CRC Press.
9. Pani, 8. (2007). Textbook of Environmental Chemistry. IK international Publishing House.

Discipline Specific Core (DSC-152)
ECOSYSTEMS, EARTH SURFACE, PHYSICS AND CHEMISTRY OF THE ENVIRONMENT (Practical)
Total Marks= 100
End Semester Examination = 70
Internal Examination= 30
Total Credits=3

(SECTION-A)

1. To study the allelopathic influence of plant species.
2. To prepare a checklist of invasive species.
3. To study the plankton communities in a freshwater ecosystem.
4. To study the roadside species.
5. Field report: Visit to a forest/ river/ wetland ecosystem.

(SECTION-B)

1. Study of the model for continental drift.
2. Identification of sedimentary and metamorphic rocks.
3. Study and interpretation of the Geological time scale.
4. Study of the Topographic map.
5. Study of landscapes of urban, semi-urban and rural areas.

(SECTION-C)

1. Determination of pH of water samples.
2. Determination of pH of soil samples.
3. To measure the soil temperature of different sites.
4. To measure the water holding capacity and moisture percentage of soil.
5. Determination of total hardness of water.

Discipline Specific Minor (DSM-151)

BASIC CONCEPTS OF ECOLOGY

Total Marks= 100

End Semester Examination = 70

Internal Examination= 30

Total Credits=3

Unit 1: Ecological concepts: (10 lectures)

Basic concepts and definitions: ecology, landscape, habitat, ecozones, biosphere, ecosystems, autecology; synecology; major terrestrial biomes; ecological amplitude; Liebig's Law of the Minimum; Shelford's Law of Tolerance; ecological niche.

Unit 2: Ecology of populations: (10 lectures)

Concept of population; r- and K-selection; characteristics of population: density, dispersion, natality, mortality, life tables, survivorship curves, age structure; population growth: geometric, exponential, logistic, density-dependent.

Unit 3: Ecology of communities: (10 lectures)

Community structure and organization: keystone species, ecotone and edge effect; species interactions: positive and negative; ecological succession and climax community.

Unit 4: Ecosystem structure and function: (10 lectures)

Types of ecosystem: Terrestrial and aquatic; abiotic and biotic components of ecosystem; food chain, food web; ecological efficiencies; ecological pyramids: pyramids of number, biomass, and energy.

Unit 5: Biogeochemical cycles: (10 lectures)

Carbon cycle; nitrogen cycle; phosphorus cycle; sulphur cycle; hydrological cycle; input of nutrients in different ecosystems; ecosystem losses; nutrient supply and uptake.

Suggested Readings:

1. Groom. B. & Jenkins. M. (2000). Global Biodiversity: Earth's Living Resources in the 21'[1] Century. World Conservation Press, Cambridge, UK.
2. Gurevitch, J., Scheiner, S. M., & Fox, G. A. (2002). The Ecology of Plants. Sinauer associates incorporated.
3. Loreau, M. & lnchausti, P. (2002). Biodiversity and Ecosystem functioning: Synthesis and Perspectives. Oxford University Press, Oxford, UK.
4. Odum, E.P. (1971). Fundamentals of Ecology. W.B. Sounders.
5. Pandit, M.K., White, S.M. & Pocock, M.J.O. (2014). The contrasting effects of genome size, chromosome number and ploidy level on plant invasiveness: a global analysis. New Phytologist203: 697-703.
6. Pimentel, D. (Ed.). 2011. Biological invasions: Economic and environmental costs of alien plant, animal, and microbe species. CRC Press.
7. Singh, J.S., Singh, S.P. & Gupta, S.R. (2006). Ecology, Environment and Resource Conservation. Anamaya Publications.
8. Wilson, E. 0. (1985). The Biological Diversity Crisis. Bio Science 35: 700-706.

Semester II

Interdisciplinary Course (IDC 151)

Name of the paper: Natural Resources, Biodiversity Conservation and Environmental Pollution

Total Marks= 100

End Semester Examination = 70

Internal Examination= 30

Total Credits=3

UNIT l: Natural Resources: (10 lectures)

Types of resource: renewable and non-renewable. Types of forest resources: its uses and importance; forest cover of India; non- timber forest products; shifting cultivation; JFM. Energy resources: fossil fuels, hydroelectric power, wind energy, solar energy, nuclear energy. Mineral Resources: types and distribution of important minerals in India.

UNIT2: Biodiversity and conservation: (10 lectures)

Definition and levels of biodiversity; biodiversity hot spots; values of Biodiversity; threats to biodiversity; conservation of biodiversity: In-situ and ex-situ conservation of biodiversity; Sacred groves of North East India; Tiger Task Force; The Indian Rhino Vision 2020; IUCN Red List Categories.

UNIT3: Environmental Pollution: (10 lectures)

Environmental pollution and pollutants; types of pollution: Air, water, soil and noise pollution: causes, effects and control; bio-magnification; particulate matter **(PM);** photochemical smog; troposheric ozone; radioactive pollutants; heavy metal pollution; eutrophication; indoor air pollutants; Solid Waste Management.

UNIT4: Major environmental issues: (10 lectures)

Climate change, greenhouse effect, global warming, ozone layer depletion, acid rain; construction of dams and associated environmental issues. Case studies: Chernobyl disaster, Kalpakkam disaster, Fukushima nuclear accidents, Minamata disaster, Bhopal gas tragedy.

UNITS: Urbanization and environment: (10 lectures)

Development-induced displacement, resettlement and rehabilitation; impact of industry and technology on environment; urban sprawl, traffic congestion and social-economic problems; Urban heat island effect; modern agriculture and environmental degradation.

Suggested readings:

1. Asthana, D. K. (2006). Text Book of Environmental Studies. S. Chand Publishing.
Climate Change: Science and Politics. (202 I). Centre for Science and Environment, New Delhi
2. De, A.K., (2006). Environmental Chemistry, 6th Edition, New Age International, New Delhi.
3. Rana S. V. S (2009) Essentials of Ecology and Environmental Science Prentice Hall of India Pvt. Ltd.,
4. Santra S.C. (2010) Fundamentals of Ecology and Environmental Biology. New Central Book Agency, Kolkata.
5. Sharma, P. D., & Sharma, P. D. (2005). Ecology and environment. Rastogi Publications.
6. Odum, E.P., Odum, H.T. & Andrews, J. (1971). Fundamentals of Ecology. Philadelphia: Saunders.

Pepper, I.L, Gerba, C.P. & Brusseau, M.L. (2011). Environmental and Pollution Science. Academic Press.
7. Singh, J.S., Singh, S.P. and Gupta, S.R. (2014). Ecology, Environmental Science and Conservation. S. Chand Publishing, New Delhi.
8. Dobson, A.P. (1996). Conservation and Biodiversity. Scientific American Library, New York, NY.
9. Groombridge, B., and M. Jenkins. (2000). Global Biodiversity: Earth's Living Resources in the 21 st Century. World Conservation Press, Cambridge, UK.
10. Primack, R.B. (2002). Essentials of Conservation Biology, 3 rdedn., Sinauer Associates, Sunderland, Ma. USA.
11. Smith, P. and Warr, K. (1991). Global Environmental Issues, Hodder and Stoughton, London.
12. IUCN. (2004). Red list of threatened species. A global species assessment. IUCN, Gland, Switzerland.

Ski lEnhancement Course (SEC-151)

ENVIRONMENTAL IMPACT AND RISK ASSESSMENT

Total Marks= 100

End Semester Examination = 50

Practical Examination= 30

Internal Test= 20

Total Credits=3

Unit 1: Concept of EIA: (08 lectures)

Environmental impact assessment (EIA): Definitions, introduction and concepts; rationale and historical development of EIA; scope and methods of EIA.

Unit 2: Components and roleof EIA: (10 lectures)

ElA - project components: Role of project proponents, project developers and consultants; Terms of Reference; impact identification and prediction; baseline data collection; Environmental Impact Statement (EIS), Environmental Management Plan (EMP).

Unit 3: EIA and Environmental management: (12 lectures)

Rapid EIA; Strategic Environmental Assessment; Social Impact Assessment; Cost Benefit analysis; Life cycle assessment; environmental appraisal; environmental management - principles, problems and strategies; environmental planning; environmental audit; introduction to ISO and ISO 14000; sustainable development.

Unit 4: EIA regulations: (08 lectures)

EIA regulations in India; status of EIA in India; current issues in EIA; case study of hydropower projects/ thermal projects.

Unit 5: Risk assessment: (10 lectures)

Introduction and scope; project planning; exposure assessment; toxicity assessment; hazard identification and assessment; risk characterization; risk communication; environmental monitoring; community involvement; legal and regulatory framework; human and ecological risk assessment.

Practicals:

1) Environmental Impact Assessment of any nearby industry, factory or similar area.
2) Studies on the biological and other waste disposal mechanism of any nearby health centre or hospital.
3) To identify harmful wastes in any given water or soil sample.
4) To visit any nearby market area and quantification of the daily waste generated from such areas.
5) Students may be asked to make some close ended questionnaire and interview the local community (n=30) on various aspects of environmental risk and environmental impact and prepare a report based on it.

Suggested Readings

1. Barrow, C.J. (2000). Social Impact Assessment: An Introduction. Oxford University Press.
2. Glasson, J., Therivel, R., Chadwick, A. (1994). Introduction to Environmental Impact Assessment. London, Research Press, UK.

3. Judith, P. (1999). Handbook of Environmental Impact Assessment. Blackwell Science. 4. Marriott, B. 1997. Environmental Impact Assessment: A Practical Guide. McGraw-Hill, NewYork, USA

SEMESTER II

Common Value Added Course (VAC-151)

ENVIRONMENTAL STUDIES

Total Marks= 100

End Semester Examination = 70

Internal Examination = 30

Total Credits=3

UNIT 1: Introduction to Environmental Studies: (12 lectures)

Definition, scope and importance of environmental studies. Concept of ecosystem; Producers, consumers and decomposers; Energy flow in an ecosystem; Food chain and food webs; Ecological pyramids; Ecological succession. Nutrient cycles (Carbon cycle and nitrogen cycle). Major ecosystems: Terrestrial (Forest) and Aquatic (Pond).

UNIT 2: Natural Resources and Management: (12 lectures)

Concepts and types of natural resources (Renewable and non-renewable). Importance, threats and management of land resources, forest resources, water resources and energy resources.

UNIT 3: Biodiversity and conservation: (12 lectures)

Definition, levels of biodiversity (genetic, species and ecosystem diversity); Endemism; global biodiversity hot spots. Biodiversity of India with special reference to North East India. Threats to Biodiversity: Habitat loss, poaching of wildlife, man-wildlife conflicts in the Indian context. *In-situ* and *ex-situ* conservation of biodiversity.

UNIT 4: Environmental pollution and climate change: (12 lectures)

Environmental pollution: Types (Air, water, soil and noise pollution), causes, effects and controls, Solid Waste Management. Climate change, global warming, ozone layer depletion, acid rain and its impact on the environment. Environment Laws: Environment Protection Act; Air (Prevention and control of pollution) Act; Water (Prevention and control of pollution); Wildlife Protection Act.

UNIT 5: Environmental ethics and disaster management: (12 lectures)

Principle and concept of environmental ethics; Animal Welfare and Animal Rights, Deep ecology, Ecofeminism, Putting environmental ethics into practice. Environmental movement and awareness: Chipko, Silent valley, Bishnois of Rajasthan. Causes, impacts and management of floods, earthquakes, cyclones and landslides.

SUGGESTED READINGS:

l. Bharucha, E. (2003). Textbook for Environmental Studies, University Grants Commission, New Delhi and Bharati Vidhyapeet Institute of Environmental Education and Research, Pune.

2. Carson, Rachel. (1962). Silent Spring (Boston: Houghton Mifflin, 1962), Mriner Books, 2002.

3. Economy, Elizabeth (2010). The River Runs Black: The Environmental Challenge to China's Future.

4. Gadgil, M. and Ramachandra, G. (1993). This fissured land: an ecological history of India. University of California Press.

5. Gleeson, B. and Low, N. (eds.) (l 999). Global Ethics and Environment, London, Routledge.

6. Grumbine, R. Edward, and Pandit, M. K. (2013). Threats from India's Himalaya dams. Science 339.6115: 36-37.

7. Heywood V. H. and Watson, R. T. (1995). Global Biodiversity Assessment. Cambridge University Press.

8. McCully, P. (1996). Silenced rivers: the ecology and politics of large dams. Zed Books.

9. McNeill, John **R.** (2000). Something New Under the Sun: An Environmental History of the Twentieth Century.

10. Odum, E. P., Odum, H. T. And Andrews, J. (1971). Fundamentals of Ecology. Philadelphia: Saunders.

I I. Pepper, I. L., Gerba, C. **P.** and Brusseau, M. L. (2011). Environmental and Pollution Science. Academic Press.

12. Rao, M. N. and Datta, A. K. (1987). Waste Water Treatment. Oxford and IBH Publishing Co. Pvt. Ltd.

13. Raven, P. H., Hassenzahl, D. M. and Berg, L. R. (2012). Environment, 8th edition. John Wiley and Sons.

14. Ricklefs, R. E. and Miller, G. L. (2000). Ecology. W. H. Freeman, New York.

15. Robbins, P. (2012): Political Ecology: A critical introduction. John Wiley and Sons.

16. Rosencranz, A., Divan, S. and Noble, M. L. (2002). Environmental law and policy in India. Oxford University Press, India.

17. Sengupta, R. (2003). Ecology and Economics: An approach to sustainable development. OUP Catalogue.

18. Singh, J. S., Singh, S. P. and Gupta, S. R. (2006). Ecology, Environment and Resource Ecology, Environment and Resource Conservation. Anamaya Publishers.

19. Sodhi, N. S., Gibson, L. and Raven, P. HG. (eds). (2013). Conservation biology: voices from the Tropics. John Wiley and Sons.

20. Van Leeuwen, C. J. and Venneire, T. G. (2007). Risk assessment of Chemicals.

2 I. World Commission on Environment and Development. (I987). Our Common Future. Oxford. Oxford University Press.

COURSE OUTLINE

Semester	Course category, marks and credit	Course title	Unit names
III	**Discipline Specific Core (DSC-201)** **Total Marks= 100** End Semester Examination= 70 Internal Examination = 30 **Total Credits=4**	**ATMOSPHERE AND GLOBAL CLIMATE CHANGE**	Global energy balance Atmospheric circulation Global warming and climate change Ozone layer depletion Climate change and policy
	Discipline Specific Core (DSC-202) **Total Marks= 100** End Semester Examination= 70 Internal Examination = 30 **Total Credits=4**	**WATER AND WATER RESOURCES**	Physico-chemical parameters of water Surface and subsurface water Water resources in India Marine resource management Water resources conflicts and policies
	Discipline Specific Minor (DSM-201) **Total Marks= 100** End Semester Examination= 70 Internal Examination = 30 **Total Credits=4**	**ATMOSPHERE AND CLIMATE CHANGE**	Energy balance Atmospheric circulation Global warming and climate change Ozone layer Climate change policies
	Interdisciplinary Course (IDC-201) **Total Marks= 100** End Semester Examination= 70 Internal Examination = 30 **Total Credits=3**	**ENVIRONMENTAL POLLUTION AND MANAGEMENT**	Concept and types Air pollution Water pollution Soil pollution Noise, radioactive and E-pollution
	Skill Enhancement Course (SEC-201) **Total Marks= 100** Total Marks= 100 End Semester Examination = 50 Practical Examination = 30 Internal Test= 20 **Total Credits=3**	**REMOTE SENSING AND GIS**	Introduction to RS and GIS Physics of remote sensing and image resolutions Image interpretation techniques Data types and data analysis in GIS Application of RS and GIS in natural resource management
IV	**Discipline Specific Core (DSC-251)** **Total Marks= 100** End Semester Examination = 70 Internal Examination = 30 **Total Credits=4**	**LAND AND SOIL DEGRADATION AND MANAGEMENT**	Fundamentals of soil science Soil degradation Landuse changes and land degradation Evaluation of land degradation Land and soil conservation

	Discipline Specific Core (DSC-252) **Total Marks= 100** End Semester Examination = 70 Internal Examination = 30 **Total Credits=4**	**SYSTEMATICS AND BIOGEOGRAPHY**	Concept and approaches to systematics Numerical and molecular systematics Introduction to biogeography Speciation and extinction Biogeography and its application
	Discipline Specific Core (DSC-253) **Total Marks= 100** End Semester Examination = 70 Internal Examination = 30 **Total Credits=4**	**AIR, WATER, SOIL & SYSTEMATICS (PRACTICAL)**	
	Discipline Specific Minor (DSM-251) **Total Marks= 100** End Semester Examination = 70 Internal Examination = 30 **Total Credits=3**	**ECOLOGY, ATMOSPHERE AND CLIMATE CHANGE (PRACTICAL)**	
	Discipline Specific Minor (DSM-252) **Total Marks= 100** End Semester Examination = 70 Internal Examination = 30 **Total Credits=3**	**CONCEPT OF ATMOSPHERE AND CLIMATE CHANGE**	Introduction and concepts Circulation of Atmosphere Global warming and climate change Ozone layer Climate change and policies

SEMESTER III
Discipline Specific Core (DSC-201)
ATMOSPHERE AND GLOBAL CLIMATE CHANGE
Total Marks= 100
End Semester Examination = 70 Internal Examination = 30
Total Credits=4

Unit 1: Global energy balance

Evolution and development of Earth's atmosphere; atmospheric structure and composition; significance of atmosphere, Methods of transfer of heat energy on earth: conduction, convection and radiation; earth atmosphere energy balance, Milankovitch cycles.

Unit 2: **Atmospheric circulation**

Movement of air masses; atmosphere and climate; air and sea interaction; southern oscillation; western disturbances; El Nino and La Nina; tropical cyclone; Indian monsoon and its development; Meteorology and atmospheric stability; meteorological parameters (temperature, air pressure, light intensity, relative humidity, wind speed and direction, precipitation); atmospheric stability and mixing heights; temperature inversion.

Unit 3: Global warming and climate change

Trends of global warming and climate change; drivers of global warming and the potential of different greenhouse gases (GHGs) causing climate change; atmospheric windows; impact of global warming; impact of climate change on the atmosphere, weather patterns, sea level rise, agricultural productivity and biological responses.

Unit 4: Ozone layer depletion

Ozone layer or ozone shield; importance of ozone layer; ozone layer depletion and causes; Chapman cycle; process of spring time ozone depletion over Antarctica; ozone depleting substances (ODS); effects of ozone depletion; mitigation measures.

Unit 5: Climate change and policy

Environmental policy debate; International agreements; Montreal protocol 1987;Kyoto protocol 1997;Paris Agreement (2015), Clean Power Plan (2015), India's Climate Change Policy; Convention on Climate Change; carbon credit and carbon trading; clean development mechanism.

Readings:

1. Barry, R. G. 2003. Atmosphere, Weather and Climate. Routledge Press, UK.
2. Gillespie, A. 2006. Climate Change, Ozone Depletion and Air Pollution: Legal Commentaries with Policy and Science Considerations. Martinus Nijhoff Publishers.
3. Hardy, J.T. 2003. Climate Change: Causes, Effects and Solutions. John Wiley & Sons.
4. Harvey, D. 2000. Climate and Global Climate Change. Prentice Hall.
5. Manahan, S.E. 2010. Environmental Chemistry. CRC Press, Taylor and Francis Group.
6. Maslin, M. 2014. Climate Change: A Very Short Introduction. Oxford Publications.
7. Mathez, E.A. 2009. Climate Change: The Science of Global Warming and our Energy Future. Columbia University Press.

8. Mitra, A.P., Sharma, S., Bhattacharya, S., Garg, A., Devotta, S. &Sen, K. 2004. Climate Change and India. Universities Press, India.
9. Philander, S.G. 2012. Encyclopedia of Global Warming and Climate Change (2ndedition). Sage Publications.
10. Ross, M.T., & Murray. B.C. 2016. What is the fuel of the future? Prospects under the Clean Power Plan. Energy Economics, 60, 451-459.
11. Savaresi, A. 2016. The Paris Agreement: A new beginning? Journal of Energy & Natural Resources Law, 34(1), 16-26.

Discipline Specific Core (DSC-202)
WATER AND WATER RESOURCES
Total Marks= 100
End Semester Examination = 70 Internal Examination = 30
Total Credits=4

Unit 1: Physico-chemical parameters of water
Sources and types of water; hydrological cycle; precipitation, runoff, infiltration, evaporation, evapo-transpiration; classification of water resources (oceans, rivers, lakes and wetlands); properties of water- Physical: temperature, colour, odour, total dissolved solids and total suspended solids; Chemical: major inorganic and organic constituents, dissolved gases, DO, COD, BOD, acidity and alkalinity, electrical conductivity.

Unit 2: Surface and subsurface water
Introduction to surface and ground water; surface and ground water pollution; water table; vertical distribution of water; formation and properties of aquifers; techniques for ground water recharge; river structure and patterns; importance of watershed and watershed management; rainwater harvesting in urban settings; rainwater harvesting in rural settings.

Unit 3: Water resources in India
Demand for water (agriculture, industrial, domestic); overuse and depletion of surface and ground water resources; water quality standards in India; Definition of a wetland; types of wetlands (fresh water and marine); ecological significance of wetlands; threats to wetlands, Ramsar Convention, 1971; major wetlands and wetland resources of NE India.

Unit 4: Marine resource management
Marine resources; commercial use of marine resources; threats to marine ecosystems and resources; marine ecosystem and resource management (planning approaches, construction techniques and monitoring of coastal zones); definition and concept ofexclusive economic zones (EEZs), criteria for determining the extent of EEZs, common challenges faced by coastal states in managing their EEZs.

Unit 5: Water resources conflicts and policies
Water resources and sharing problems, multi-purpose river valley projects in India and their environmental and social impacts; case studies of dams- Narmada and Tehri dam – social and ecological losses versus economic benefits; International conflicts on water sharing between India and her neighbours; National water policy; National River linking plan.

Readings

1. Bansil, P.C. 2004. Water Management in India. Concept Publishing Company, India.
2. Brebbia, C.A. 2013. Water Resources Management VII. WIT Press.
3. CEA. 2011. Water Resources and Power Maps of India. Central Board of Irrigation & Power.
4. Grumbine, R.E. & Pandit, M.K. 2013. Threats from India's Himalaya dams. Science 339: 36-37.
5. Loucks, D.P., Stedinger, J.R. & Haith, D. A. 1981. Water Resource Systems Planning and Analysis. Englewood Cliffs, NJ, Prentice Hall.
6. Mays, L.W. 2006. Water Resources Sustainability. The McGraw-Hill Publications.
7. Schward& Zhang, 2003. Fundamentals of Groundwater. John Willey and Sons.
8. Souvorov, A.V. 1999. Marine Ecologonomics: The Ecology and Economics of Marine Natural Resource Management. Elsevier Publications.
9. Vickers, A. 2001. Handbook of Water Use and Conservation. WaterPlow Press.

Discipline Specific Minor (DSM-201)
ATMOSPHERE AND CLIMATE CHANGE
Total Marks= 100
End Semester Examination = 70 Internal Examination = 30
Total Credits=4

Unit 1: Introduction and concepts

Evolution and development of Earth's atmosphere; atmospheric structure and composition; significance of atmosphere, transfer of heat energy, Milankovitch cycles.

Unit 2: **Atmospheric circulation**

Movement of air masses; atmosphere and climate; air and sea interaction; southern oscillation; western disturbances; El Nino and La Nina; meteorological parameters (temperature, air pressure, light intensity, relative humidity, wind speed and direction, precipitation); atmospheric stability.

Unit 3: Global warming and climate change

Trends of global warming and climate change; drivers of global warming and the potential of different greenhouse gases (GHGs) causing climate change; impact of global warming; impact of climate change on the atmosphere, weather patterns, sea level rise, agricultural productivity and biological responses.

Unit 4: Ozone layer

Ozone layer or ozone shield; importance of ozone layer; ozone layer depletion and causes; Chapman cycle; process of spring time ozone depletion over Antarctica; ozone depleting substances (ODS); effects of ozone depletion; mitigation measures.

Unit 5: Climate change policies

Environmental policy debate; International agreements; Montreal protocol 1987; Kyoto protocol 1997; Paris Agreement (2015), Clean Power Plan (2015), India's Climate Change Policy; Convention on Climate Change; carbon credit and carbon trading; clean development mechanism.

Suggested Readings:

1. Barry, R. G. 2003. Atmosphere, Weather and Climate. Routledge Press, UK.
2. Gillespie, A. 2006. Climate Change, Ozone Depletion and Air Pollution: Legal Commentaries with Policy and Science Considerations. Martinus Nijhoff Publishers.
3. Hardy, J.T. 2003. Climate Change: Causes, Effects and Solutions. John Wiley & Sons.
4. Harvey, D. 2000. Climate and Global Climate Change. Prentice Hall.
5. Manahan, S.E. 2010. Environmental Chemistry. CRC Press, Taylor and Francis Group.
6. Maslin, M. 2014. Climate Change: A Very Short Introduction. Oxford Publications.
7. Mathez, E.A. 2009. Climate Change: The Science of Global Warming and our Energy Future. Columbia University Press.
8. Mitra, A.P., Sharma, S., Bhattacharya, S., Garg, A., Devotta, S. &Sen, K. 2004. Climate Change and India. Universities Press, India.
9. Philander, S.G. 2012. Encyclopedia of Global Warming and Climate Change (2ndedition). Sage Publications.

10. Ross, M.T., & Murray. B.C. 2016. What is the fuel of the future ? Prospects under the Clean Power Plan. Energy Economics, 60, 451-459.

11. Savaresi, A. 2016. The Paris Agreement: A new beginning ? Journal of Energy & Natural Resources Law, 34(1), 16-26.

Interdisciplinary course (IDC-201)
ENVIRONMENTAL POLLUTION AND MANAGEMENT
No. of Credits: 3
Total Marks=100
End Semester Examination = 70 Internal Examination = 30
Theory

Unit 1: Concept and Types

Definition of pollution; pollutants; sources- point source, non- point source; classification of pollutants- Natural and Anthropogenic; biodegradable and non- biodegradable; Environmental pollution- sources, causes, types; effects of pollution on environment and human health.

Unit 2: Air pollution

Ambient air quality: air quality index; sources and types of pollutants (primary and secondary); smog (case study); effects of different pollutants on environment and human health (NOx, SOx, PM, CO, CO2, hydrocarbons and VOCs) and control measures; indoor air pollution.

Unit 3: Water pollution

Sources of surface and ground water pollution; water quality parameters and standards; eutrophication; effect of water contaminants on human health (nitrate, fluoride, arsenic, chlorine, cadmium, mercury, pesticides); water borne diseases.

Unit 4: Soil pollution

Concepts of soil pollution and degradation; Causes of soil pollution and degradation; effect of soil pollution on environment, vegetation and other life forms; control strategies, Soil erosion

Unit 5: Noise pollution, Radioactive and E-pollution

Noise pollution – sources; permissible ambient noise levels; impacts; Radioactive materials and sources of radioactive pollution; effects of radiation; E- Pollution- sources; effects on environment and human health.

Suggested Readings:

1. Gurjar, B.R., Molina, L.T.& OjhaC.S.P.2010. Air Pollution:Health and Environmental Impacts. CRC Press, Taylor & Francis.
2. Hester, R.E.& Harrison, R.M. 1998. Air Pollution and Health. The Royal Society of Chemistry, UK.
3. Park, K. 2015. Park's Textbook of Preventive and Social Medicine (23rd edition). Banarsi das Bhanot Publishers.
4. Pepper, I.L., Gerba, C.P. & Brusseau, M.L. 2006. Environmental and Pollution Science. Elsevier Academic Press.
5. Purohit, S.S.& Ranjan, R. 2007. Ecology, Environment & Pollution. Agrobios Publications.
6. Vesilind, P.J., Peirce, J.J., &Weiner R.F. 1990. Environmental Pollution and Control. Butterworth-Heinemann, USA.

Skill Enhancement Course (SEC-201)
REMOTE SENSING AND GIS
Total Marks= 100
End Semester Examination = 70 Internal Examination = 30
Total Credits=3

Unit 1: Introduction to RS and GIS

History and evolution of RS & GIS, types of RS, platforms and sensors, satellite mission in India, concept of GIS, components of GIS, integration of RS & GIS

Unit 2: Physics of remote sensing and image resolutions

Electromagnetic spectrum and its components, interaction of electromagnetic radiations with atmosphere, principle of transmission, absorption, reflection and emission, spectral signatures, concept and types of image resolutions

Unit 3: Image interpretation techniques

Visual interpretation techniques, elements of visual interpretation, digital interpretation techniques, supervised classification, unsupervised classification, introduction to advanced classification techniques of satellite imageries

Unit 4: Data types and data analysis in GIS

Projection systems, georeferencing, types of data, overlaying of data, querying of data, concept of digital elevation model

Unit 5: Application of RS and GIS

RS and GIS in forestry, water related studies, atmospheric studies, climate change monitoring, geological and geomorphological studies and urban studies

Readings:

Joseph G., and Jeganathan C. (2018). *Fundamentals of Remote Sensing* (3rdedn.). University Press.
Lillesand T. M.; Kiefer R. W. and Chipman J.W. (2015) *Remote Sensing and Image Interpretation.* (7th edn.) Wiley India.
Bhatta Basudeb (2021). Remote Sensing and GIS, (2nd edn.) Oxford University Press India
Newton, A.C. (2007). *Forest Ecology and Conservation: A Handbook of Techniques*. Oxford University Press.
Galati Stephen R. (2006). Geographic Information Systems Demystified. Artech House, Boston.
Canada Centre for remote sensing tutorial (2019) Fundamentals of Remote Sensing (available online)

Practicals on Remote Sensing and GIS

1. Browsing and downloading Satellite Imageries.
2. Ground truthing techniques.
3. Functioning of the handheld navigation system.
4. Interpretation of toposheets.
5. Finding geographic coordinates on toposheets.

Readings:

1. Sahoo, R.N., Sehgal, V.K., Pradhan, S., Gupta, V.K. and Kamble, K.H. 2012, Practical Manual on Basics of Remote Sensing Data Processing, GPS and GIS, Division of Agricultural Physics, Indian Agricultural Research Institute, New Delhi – 110 012, India, pp 100.

2. Lavender, S., & Lavender, A. (2023). Practical handbook of remote sensing. CRC Press.

3. Boro, A. (2021). *Handbook of Practicals in Remote Sensing GIS and GPS for Beginners*. Paperback edition.

4. Díaz-Delgado, R., Lucas, R., & Hurford, C. (2017). The Roles of Remote Sensing in Nature Conservation. A pratical guide and case studies, 1st ed, Cham, Switzerland: Springer, 1-318.

SEMESTER IV

DISCIPLINE SPECIFIC CORE (DSC- 251)
LAND AND SOIL DEGRADATION AND MANAGEMENT
Total Marks= 100
End Semester Examination = 70 Internal Examination = 30
No. of Credits: 4
Theory

Unit 1: Fundamentals of soil science

Land as a resource, soil health; soil formation; classification of soil; physical properties of soil; soil texture; soil water holding capacity; soil organic matter; soil micronutrients (nitrogen, sulphur, potassium and phosphorus)

Unit 2: Soil degradation

Types and causes of soil degradation; types of soil erosion; nutrient depletion; impact of soil loss and soil degradation on agriculture and food security; soil pollution due to mining and mineral extraction, industrial and urban development, toxic contaminants in soils(organic and inorganic).

Unit 3: Landuse changes and land degradation

Biological and physical phenomena in land degradation; visual indicators of land degradation; drivers of land degradation - deforestation, desertification; habitat loss, loss of biodiversity; range land degradation; land salinization; human population pressure, poverty, socio-economic and institutional factors;

Unit 4: Evaluation of land degradation

Economic valuation of land degradation; onsite and offsite costs of land degradation; loss of ecosystem services; effects on farming communities; effects on food security; effects on nutrient cycles.

Unit 5: Land and soil conservation

Sustainable land use planning; need for soil conservation and restoration of soil fertility; role of databases and data analysis in landuse planning control and management; land tenure and land policy; participatory land degradation assessment; integrating land degradation assessment into conservation.

Suggested Readings:

1. Brady, N.C. & Well, R.R. 2007. The Nature and Properties of Soils (13th edition), Pearson Education Inc.
2. Gadgil, M.1993. Biodiversity and India's degraded lands. Ambio 22:167-172.
3. Johnson, D.L. 2006. Land Degradation (2nd edition). Rowman and Littlefield publishers
4. Marsh,W.M.&Dozier,J.1983.LandscapePlanning:EnvironmentalApplications.JohnWileyand Sons.
5. Oldeman, L.R. 1994. The global extent of soil degradation. Soil resilience and sustainable landuse, 9. (http://library.wur.nl/isric/fulltext/isricu_i26803_001.pdf).
6. Pandit, M.K. et.al. 2007. Unreported yet massive deforestation driving loss of endemic

biodiversity in Indian Himalaya. Biodiversity Conservation16:153-163.
7. Pandit, M.K. & Kumar, V. 2013. Landuse and conservation challenges in Himalaya: Past, present and future. In: Sodhi, N.S., Gibson,L.&Raven, P.H. Conservation Biology:Voices from the Tropics. pp.123-133.Wiley-Blackwell,Oxford,UK
8. Peterson, G.D., Cumming, G.S. & Carpenter, S.R. 2003. Scenario planning: a tool for conservation in an uncertain world. Conservation Biology17:358-366.

9. Scherr, S.J. 1999. Soil degradation: A threat to developing-country food security by2020 (Vol. 27). International Food Policy Research Institute.

Discipline Specific Core (DSC-252)
SYSTEMATICS AND BIOGEOGRAPHY
Credits= 4
TOTAL MARKS: 100
End Semester Examination = 70 Internal Examination = 30

UNIT:1 CONCEPT AND APPROACHES TO SYSTEMATICS
Definition of systematics; taxonomic identification; keys; field inventory; herbarium; museum; botanical gardens; taxonomic literature; nomenclature; evidence from anatomy, palynology, ultrastructure, cytology, phyto-chemistry,; taxonomy databases.

UNIT:2 NUMERICAL AND MOLECULAR SYSTEMATICS
Characters; variations; Operational Taxonomic Units; character weighting and coding; phenograms; cladograms; DNA barcoding; phylogenetic tree (rooted, unrooted, ultrametric trees); clades: monophyly, paraphyly, polyphyly, homology and analogy; parallelism and convergence.

UNIT:3 INTRODUCTION TO BIOGEOGRAPHY
Genes as unit of evolutionary change; mutation; genetic drift; gene flow; natural selection; geographic and ecological variation; Concepts of biogeography; biogeographical rules- Gloger's rule, Bergmann's rule, Allen's rule, Geist rule.

UNIT:4 SPECIATION AND EXTINCTION
Types and processes of speciation- allopatric, parapatric, sympatric; ecological diversification; adaptive radiation, convergent and parallel evolution; dispersal and immigration; means of dispersal and barriers to dispersal; extinction.

UNIT:5 BIOGEOGRAPHY AND ITS APPLICATION
Biogeographical zones of India; Biogeography of North-East India; Application of biogeographical rules in design of protected area and biosphere reserves; biogeographical realms and their fauna; endemic, rare, exotic, and cosmopolitan species.

Suggested Readings:

1. Lomolino, M.V., Riddle, B.R., Whittaker, R.J. & Brown, J.H. 2010. Biogeography (4th edition). Sinauer Associates, Sunderland
2. Mani, M.S. 1974. Ecology and Biogeography in India. Dr. W Junk Publishers., The Hague.
3. Singh, G. 2012. Plant Systematics: Theory and Practice (3rd edition). Oxford & IBH Pvt. Ltd., New Delhi.
4. Wheeler, Q.D. & Meier R. 2000. Species Concepts and Phylogenetic Theory: A Debate. Columbia University Press, New York.
5. Williams, D. M., Ebach, M.C. 2008. Foundations of Systematics and Biogeography. Springer.
6. Wilkins , J. S. 2009. Species: A History of the Idea (Vol. 1). University of California Press.
7. Krishnamurthy, K.V. 2004. An Advanced Text Book of Biodiversity- Principles and Practices . Oxford and IBH publications Co. Pvt. Ltd. New Delhi.
8. Gaston, K. J. & Spicer, J.I. 1998. Biodiversity: An Introduction. Blackwell Science, London, UK.

PRACTICAL
Discipline Specific Core (DSC-253)
AIR, WATER, SOIL & SYSTEMATICS
Total Marks- 100
End Semester Examination = 70 Internal Examination = 30
Total Credits-4

SECTION- A

1. Comparative analysis of the maximum-minimum temperature of the past 30 years using data obtained from a meteorological station.
2. Study of heat-island effect.
3. Field visit to a nearby meteorological station.

SECTION- B

1. To determine the pH of water of different water bodies (Pond, River, Lakes & Groundwater)
2. To determine the transparency of water of the pond ecosystem using Secchi disc.
3. Study of simple ecosystems-pond, river etc. and submit a report.
4. Visit to an area to document environmental assets: river/ forest/ flora/fauna, etc.
5. Visit to a wetland ecosystem and submit a report

SECTION- C

1. To determine the colour of soil samples by Munsell-soil colour chart.
2. To determine the pH of soil sampler by pH meter.
3. To determine the texture of soil sampler by sieving method.
4. To determine the moisture content of soil sampler by oven drying method.
5. To study the profile of a soil in the field.

SECTION-D

1. Mounting of a properly dried and pressed specimen of any wild plant with herbarium label.
2. To prepare a checklist of birds in and around the college campus.
3. Visit to a centre of Botanical Survey of India.

PRACTICAL
Discipline Specific Minor (DSM-251)
ECOLOGY, ATMOSPHERE AND CLIMATE CHANGE
Total Marks- 100
End Semester Examination = 70 Internal Examination = 30
Total Credits-3

SECTION- A

1. To study the allelopathic influence of one plant species.

2. To prepare a checklist of invasive species.

3. To study the plankton communities in a freshwater ecosystem.

4. To study the distribution of roadside species and investigate the changes in species richness.

5. Field report: Visit to a forest/ river/ wetland ecosystem.

SECTION- B

1. Comparative analysis of the maximum-minimum temperature of past 30 years using data obtained from a meteorological station.

2. Study of heat-island effect.

3. Field visit to a nearby meteorological station.

Discipline Specific Minor (DSM-252)
CONCEPT OF ATMOSPHERE AND CLIMATE CHANGE
Total Marks= 100
End Semester Examination = 70 Internal Examination = 30
Total Credits=3

Unit 1: Introduction and concepts

Evolution and development of Earth's atmosphere; atmospheric structure and composition; significance of atmosphere, transfer of heat energy, Milankovitch cycles.

Unit 2: **Circulation of Atmosphere**

Movement of air masses; atmosphere and climate; air and sea interaction; southern oscillation; western disturbances; El Nino and La Nina; meteorological parameters (temperature, air pressure, light intensity, relative humidity, wind speed and direction, precipitation); atmospheric stability.

Unit 3: Global warming and climate change

Trends of global warming and climate change; drivers of global warming and the potential of different greenhouse gases (GHGs) causing the climate change; atmospheric windows; impact of global warming; impact of climate change on atmosphere, weather patterns, sea level rise, agricultural productivity and biological responses.

Unit 4: Ozone layer

Ozone layer or ozone shield; importance of ozone layer; ozone layer depletion and causes; Chapman cycle; process of spring time ozone depletion over Antarctica; ozone depleting substances (ODS); effects of ozone depletion; mitigation measures.

Unit 5: Climate change and policies

Environmental policy debate; International agreements; Montreal protocol 1987; Kyoto protocol 1997; Paris Agreement (2015), Clean Power Plan (2015), India's Climate Change Policy; Convention on Climate Change; carbon credit and carbon trading; clean development mechanism.

Suggested Readings:

1. Barry, R. G. 2003. Atmosphere, Weather and Climate. Routledge Press, UK.
2. Gillespie, A. 2006. Climate Change, Ozone Depletion and Air Pollution: Legal Commentaries with Policy and Science Considerations. Martinus Nijhoff Publishers.
3. Hardy, J.T. 2003. Climate Change: Causes, Effects and Solutions. John Wiley & Sons.
4. Harvey, D. 2000. Climate and Global Climate Change. Prentice Hall.
5. Manahan, S.E. 2010. Environmental Chemistry. CRC Press, Taylor and Francis Group.
6. Maslin, M. 2014. Climate Change: A Very Short Introduction. Oxford Publications.
7. Mathez, E.A. 2009. Climate Change: The Science of Global Warming and our Energy Future. Columbia University Press.
8. Mitra, A.P., Sharma, S., Bhattacharya, S., Garg, A., Devotta, S. &Sen, K. 2004. Climate Change and India. Universities Press, India.
9. Philander, S.G. 2012. Encyclopedia of Global Warming and Climate Change (2ndedition). Sage Publications.

10. Ross, M.T., & Murray. B.C. 2016. What is the fuel of the future ? Prospects under the Clean Power Plan. Energy Economics, 60, 451-459.
11. Savaresi, A. 2016. The Paris Agreement: A new beginning ? Journal of Energy & Natural Resources Law, 34(1), 16-26.

COURSE OUTLINE

Semester	Course category, marks and credit	Course title	Units
V	**Discipline Specific Core (DSC-301)** **Total Marks= 100** End Semester Examination= 70 Internal Examination = 30 **Total Credits=4**	**HUMAN-WILDLIFE CONFLICT AND MANAGEMENT**	Introduction to wildlife conflict Concept of wildlife management Wildlife conservation Socio-economic and legal basis of conflicts Human wildlife coexistence
	Discipline Specific Core (DSC-302) **Total Marks= 100** End Semester Examination= 70 Internal Examination = 30 **Total Credits=4**	**URBAN ECOSYSTEMS**	Concept of urbanization Urban Environment Urban dwelling Urban interface with the environment Urban Planning and environmental management
	Discipline Specific Core (DSC-303) **Total Marks= 100** End Semester Examination= 70 Internal Examination = 30 **Total Credits=4**	**HUMAN-WILDLIFE CONFLICT AND URBAN ECOSYSTEMS (PRACTICAL)**	-
	Discipline Specific Minor (DSM-301) **Total Marks= 100** End Semester Examination= 70 Internal Examination = 30 **Total Credits=3**	**HUMAN-WILDLIFE INTERACTION**	Human wildlife interaction Concept of wildlife management Wildlife conservation Socio-economic and legal basis of conflicts Human wildlife coexistence
	Discipline Specific Minor (DSM-302) **Total Marks= 100** End Semester Examination= 70 Internal Examination = 30 **Total Credits=3**	**-WILDLIFE MANAGEMENT**	Introduction to wildlife conflict Concept of wildlife management Wildlife conservation Socio-economic and legal basis of conflicts Human wildlife coexistence
		INTERNSHIP WITH INDUSTRY/COMMUNITY ENGAGEMENT/ FIELD STUDY **TOTAL CREDITS: 2** **TOTAL MARKS:- 50**	

Discipline Specific Core (DSC-301)
Total Marks= 100
End Semester Examination= 70 Internal Examination = 30
Total Credits=4
HUMAN-WILDLIFE CONFLICT AND MANAGEMENT

Unit 1: Introduction to wildlife conflict (8 lectures)

Human wildlife conflicts; insight into the important conflicts: case studies related to human-wildlife conflicts of North East India; role of government, wildlife biologists, and social scientists, and general public in human wildlife conflicts

Unit 2: Concept of wildlife management (10 lectures)

Philosophy of wildlife management;Prehistoric association between wildlife and humans: records from Bhimbetka wall paintings; conservation of wildlife in the reign of king Ashoka: excerpts from rock edicts; Bishnoi community; conservation and policies regarding protected areas in 21st century; values of wildlife management (monetary, recreational, scientific and ecological benefits).

Unit 3: Wildlife conservation (8 lectures)

Types of protected areas (Wildlife Sanctuaries, National Parks, Biosphere Reserves); IUCN categories of protected areas, Natural World Heritage sites; concept of core and buffer area in a protected range, introduction of Tiger Task Force, status of current protected areas in India, Man and Biosphere programmes, brief introduction to Wildlife Protection Act of 1972

Unit 4: Socio-economic and legal basis of conflicts (12 lectures)

Concepts of development and encroachment, impact of conflict on humans and wildlife, impact of habitat fragmentation, social inequality in terms of forest conservation:, conflicting issues within protected areas, forest produce as a need vs. forest exploitation, importance of forest produce to tribal populations, Scheduled Tribes and other traditional forest dwellers (Recognition of Forest Rights) Act, 2006.

Unit 5: Human wildlife coexistence (12 lectures)

Symbiotic relationship between tribals and forest, forest and development, focus on the inclusive growth of tribes: community participation in forest management, sacred groves, ecological-economic welfare and development, conservation of indigenous culture and traditions, concept of conservation reserves and community reserves, importance of wildlife corridors in minimizing conflicts and conservation.

Suggested Readings

1. Conover, M. 2001. Resolving Human Wildlife Conflicts, CRC Press.
2. Dickman, A. J. 2010. Complexities of conflict: the importance of considering social factors for effectively resolving human–wildlife conflict. Animal Conservation 13: 458-466.
3. Messmer, T. A. 2000. The emergence of human–wildlife conflict management: Turning challenges into opportunities. International Biodeterioration & Biodegradation 45: 97-102.
4. Paty, C. 2007. Forest Government and Tribe. Concept Publishing Company.
5. Treves, A. & Karanth, K. U. 2003. Human-carnivore conflict and perspectives on carnivore management worldwide. Conservation Biology 17: 1491-1499.
6. Woodroffe, R. 2005. People and Wildlife: Conflict and Coexistence. Cambridge.
7. Woodroffe, R., Thirgood, S., & Rabinowitz, A. 2005. People and Wildlife, Conflict or Coexistence? (No. 9). Cambridge University Press.

Discipline Specific Core (DSC-302)
Total Marks= 100
End Semester Examination= 70 Internal Examination = 30
Total credits: 4

URBAN ECOSYSTEMS

Unit 1: Concept of urbanization (10 lectures)

Introduction to urbanization; urban sprawl and associated environmental issues; concept of 'controlled nature'; scope, importance and threats to nature in the city; organization and planning of green and blue spaces such as parks, gardens and aquatic bodies.

Unit 2: Urban Environment (14 lectures)

Man as the driver of urban ecosystem; commodification of nature; metros, cities and towns as sources and sinks of resources; resource consumption and its social, economic and ecological perspectives; urban transformation; challenges in urban settings; urban pollution (air, water, soil).

Unit 3: Urban dwelling (12 lectures)

Poverty and slums in an urban context; Town planning Acts and their environmental aspects; Challenges in urban housing: energy consumption, waste disposal and accumulation; environmental costs of urban infrastructure.

Unit 4: Urban interface with the environment (12 lectures)

Management of urban environment; alternative resources; policy and management decisions; urban settings as loci of sustainability; challenges associated with sustainability and urban future; peri-urban interfaces with special reference to India.

Unit 5: Urban Planning and Environmental Management (12 lectures)

Urban planning and its environmental aspects from historical and contemporary perspectives; benefits of environmental management; introduction to green buildings; urban governance; smart cities, star cities.

Suggested Readings

1. D'Monte, Darryl. 1985. Industry versus Environment Temples or Tombs. Three Controversies, Delhi, CSE.
2. Gaston, K.J. 2010. Urban Ecology. Cambridge University Press, New York.
4. Grimm, N. B., Faeth, S. H., et al. 2008. Global Change and the Ecology of Cities. Science 319: 756-760.
5. Hinchliffe, S. & Whatmore, S. 2006. Living cities: Towards a politics of conviviality. Science as Culture 15: 123–138.
7. Montgomery, M.R. 2009. Urban Transformation of the developing world. Science 319: 761-764.

Discipline Specific Core (DSC-303)

Total Marks= 100

End Semester Examination= 70 Internal Examination = 30

Total Credits=4

HUMAN-WILDLIFE CONFLICT AND URBAN ECOSYSTEMS (PRACTICAL)

SECTION – A

1. To study the animal diversity of a disturbed site.
2. Identification of important food plants of mammals in a given area.
3. Study of methods of animal diversity measurement.
4. Study of the strategy of preventing and managing human-wildlife conflicts.
5. Project on human-wildlife conflicts.
6. Field trip to protected areas (Reserve forest/ Wildlife sanctuary- optional).

SECTION – B

1. Measurement of air, water and soil pollution in urban areas.
2. Comparative study of the availability of resources in an urban area and a rural area.
3. Measurement of density of population (this can be done in any three representative locations in any urban area) and identifying the major issues faced by urban population.
4. Measurement and quantification of green space in any office premise/ college premise/ total urban area.
5. Assessment of green parameters in any building (like air circulation/ light availability/ environment friendly aspects etc.).
6. Visit to a nearby slum area and submission a report on the same based on health and hygiene and environmental aspects.

Discipline Specific Minor (DSM-301)

Total Marks= 100

End Semester Examination= 70 Internal Examination = 30

Total Credits=3

HUMAN-WILDLIFE INTERACTION

Unit 1: Human wildlife interaction (8 lectures)

Philosophy of wildlife management; human wildlife conflicts and role of government, wildlife biologists and social scientists, insight into the important conflicts: human and wildlife conflicts of North East India.

Unit 2: Concept of wildlife management (10 lectures)

Understanding wildlife management, the Bishnoi community; conservation and policies regarding protected areas in the 21st century; values of wildlife management, positive values provided by wildlife conservation (monetary, recreational, scientific and ecological benefits).

Unit 3: Wildlife conservation (8 lectures)

Strategies of wildlife conservation (i*n-situ* & *ex-situ*); IUCN categories of protected areas, Natural World Heritage sites; concept of core and buffer area in a protected range, introduction of Tiger Task Force, status of current protected areas in India, brief introduction to Wildlife Protection Act of 1972.

Unit 4: Socio-economic and legal basis of conflicts (12 lectures)

Concepts of development and encroachment, impact of conflict on humans and wildlife, impact of habitat fragmentation, social inequality in terms of forest conservation: forest produce as a need vs. forest exploitation, introduction to tribal rights in India, importance of forest produce to tribal populations, Scheduled Tribes and other traditional forest dwellers (Recognition of forest right) Act, 2006.

Unit 5: Human wildlife coexistence (12 lectures)

Symbiotic relationship between tribals and forest, community participation in forest management, sacred groves, India's Bishnoi community and their conservation practices; role of international organizations: Man and biosphere programmes; concept of conservation reserves and community reserves, importance of wildlife corridors.

Suggested Readings

1. Conover, M. 2001. Resolving Human Wildlife Conflicts, CRC Press.
2. Dickman, A. J. 2010. Complexities of conflict: the importance of considering social factors for effectively resolving human–wildlife conflict. Animal Conservation 13: 458-466.
3. Messmer, T. A. 2000. The emergence of human–wildlife conflict management: Turning challenges into opportunities. International Biodeterioration & Biodegradation 45: 97-102.
4. Paty, C. 2007. Forest Government and Tribe. Concept Publishing Company.
5. Treves, A. & Karanth, K. U. 2003. Human-carnivore conflict and perspectives on carnivore management worldwide. Conservation Biology 17: 1491-1499.
6. Woodroffe, R. 2005. People and Wildlife: Conflict and Coexistence. Cambridge.
7. Woodroffe, R., Thirgood, S., & Rabinowitz, A. 2005. People and Wildlife, Conflict or Coexistence? (No. 9). Cambridge University Press.

Discipline Specific Minor (DSM-302)

Total Marks= 100

End Semester Examination= 70 Internal Examination = 30

Total Credits=3

WILDLIFE MANAGEMENT

Unit 1: Human wildlife interaction (8 lectures)

Philosophy of wildlife management; human wildlife conflicts and role of government, wildlife biologists and social scientists, human and wildlife conflicts of North East India.

Unit 2: Concept of wildlife management (10 lectures)

Understanding wildlife management, the Bishnoi community; conservation and policies regarding protected areas in the 21st century; values of wildlife management, positive values provided by wildlife conservation (monetary, recreational, scientific and ecological benefits).

Unit 3: Wildlife conservation (8 lectures)

Strategies of wildlife conservation (*In-situ* & *Ex-situ*); IUCN categories of protected areas, Natural World Heritage sites; concept of core and buffer area in a protected range, introduction of Tiger Task Force, status of current protected areas in India, brief introduction to Wildlife Protection Act of 1972.

Unit 4: Socio-economic and legal basis of conflicts (12 lectures)

Concepts of development and encroachment, impact of conflict on humans and wildlife, impact of habitat fragmentation, social inequality in terms of forest conservation: forest produce as a need vs. forest exploitation, introduction to tribal rights in India, importance of forest produce to tribal populations, Scheduled Tribes and other traditional forest dwellers (Recognition of Forest Right) Act, 2006.

Unit 5: Human wildlife coexistence (12 lectures)

Symbiotic relationship between tribals and forest, community participation in forest management, sacred groves; India's Bishnoi community and their conservation practices; role of international organizations: Man and Biosphere Programmes; concept of conservation reserves and community reserves, importance of wildlife corridors.

Suggested Readings

1. Conover, M. 2001. Resolving Human Wildlife Conflicts, CRC Press.
2. Dickman, A. J. 2010. Complexities of conflict: the importance of considering social factors for effectively resolving human–wildlife conflict. Animal Conservation 13: 458-466.
3. Messmer, T. A. 2000. The emergence of human–wildlife conflict management: Turning challenges into opportunities. International Biodeterioration & Biodegradation 45: 97-102.
4. Paty, C. 2007. Forest Government and Tribe. Concept Publishing Company.
5. Treves, A. & Karanth, K. U. 2003. Human-carnivore conflict and perspectives on carnivore management worldwide. Conservation Biology 17: 1491-1499.
6. Woodroffe, R. 2005. People and Wildlife: Conflict and Coexistence. Cambridge.
7. Woodroffe, R., Thirgood, S., & Rabinowitz, A. 2005. People and Wildlife, Conflict or Coexistence? (No. 9). Cambridge University Press.

Semester	Course category, marks and credit	Course title	Units
VI	**Discipline Specific Core (DSC-351)** **Total Marks= 100** End Semester Examination = 70 Internal Examination = 30 **Total Credits=4**	**ENVIRONMENT AND SOCIETY**	Issues in environmentalism Development and-environment conflict Urbanization and environment Regulatory framework Community participation
	Discipline Specific Core (DSC-352) **Total Marks= 100** End Semester Examination = 70 Internal Examination = 30 **Total Credits=4**	**BIODIVERSITY AND CONSERVATION**	Biodiversity patterns Biodiversity estimation Importance of biodiversity Threats to biodiversity Conservation of biodiversity in India
	Discipline Specific Core (DSC-353) **Total Marks= 100** End Semester Examination = 70 Internal Examination = 30 **Total Credits=4**	**ENERGY AND ENVIRONMENT**	Energy resources Energy demand Energy, environment and society Energy production and the environment Future energy
	Discipline Specific Core (DSC-354) **Total Marks= 100** End Semester Examination = 70 Internal Examination = 30 **Total Credits=4**	**GENDER AND ENVIRONMENT, BIODIVERSITY CONSERVATION, ENERGY AND ENVIRONMENT (PRACTICAL)**	-
	Discipline Specific Minor (DSM-351) **Total Marks= 100** End Semester Examination = 70 Internal Examination = 30 **Total Credits=4**	**ECOLOGY, ATMOSPHERE AND CLIMATE (PRACTICAL)**	

Discipline Specific Core (DSC-351)
Marks: 100
Total Credits: 4
End Semester Examination = 70 Internal Examination = 30

ENVIRONMENT AND SOCIETY

Unit 1: Issues in environmentalism (12 lectures)
Significant global environmental issues such as acid rain, climate change, global warming, major greenhouse gases; resource depletion; interaction between environment and society.

Unit 2: Development and-environment conflict (12 lectures)
Developmental issues and related impacts such as ecological degradation; environmental pollution; development-induced displacement, resettlement, and rehabilitation: problems, concerns, and compensative mechanisms.

Unit 3: Urbanization and environment (12 lectures)
Production and consumption oriented approaches to environmental issues in Indian as well as global context; impact of industry and technology on the environment; urban sprawl, traffic congestion and socio-economic problems.

Unit 4: Regulatory framework (12 lectures)
Development of regulatory frameworks; Concept of EIA and SIA; Forest Conservation Act 1980,1988; Forest Rights Act 2006; Land Acquisition Act 1894, 2012; Enforcement of the acts and societal benefits.

Unit 5: Community participation (12 lectures)
State, corporate, civil society, community, and individual-level initiatives to ensure sustainable development; case studies of environmental movements (Appiko Movement, Chipko Movement, Narmada BachaoAndolan); role of NGOs; environmental education and awareness.

Suggested Readings

1. Chokkan, K.B., Pandya, H. & Raghunathan, H. (eds). 2004. Understanding Environment. Sagar Publication India Pvt. Ltd., New Delhi.
2. Elliot, D. 2003. Energy, Society and Environment, Technology for a Sustainable Future. Routledge Press.
3. Guha, R. 1989. Ecological change and peasant resistance in the Himalaya. Unquiet Woods, Oxford University Press, Delhi.
4. Leopold, A. 1949. The Land Ethic. pp. 201-214. Chicago, USA.
5. National Research Council (NRC). 1996. Linking Science and Technology to Society's Environmental Goals. National Academy Press.
6. Pandit, M.K. 2013. Chipko: Failure of a Successful Conservation Movement. In: Sodhi, N.S.,
Gibson, L. & Raven, P.H. Conservation Biology: Voices from the Tropics. pp. 126-127. Wiley-
Blackwell, Oxford, UK.

Discipline Specific Core (DSC-352)

Total Marks= 100

End Semester Examination = 70 Internal Examination = 30

Total credits: 4

BIODIVERSITY AND CONSERVATION

Unit 1: Biodiversity patterns (10 lectures)

Spatial patterns: latitudinal and elevational trends in biodiversity; temporal patterns: seasonal fluct uations in biodiversity patterns; importance of biodiversity patterns in conservation.

Unit 2: Biodiversity estimation (12 lectures)

Sampling strategies and surveys: floristic, faunal, and aquatic; qualitative and quantitative methods: scoring, richness, density, frequency, abundance, evenness, diversity, community diversity estimation: alpha, beta and gamma diversity; NCBI database, BLAST analyses.

Unit 3: Importance of biodiversity (12 lectures)

Values of biodiversity: social, aesthetic, consumptive, and ethical, Economic values (medicinal plants, drugs, fisheries and livelihoods);ecological services –primary productivity, role in hydrological cycle, biogeochemical cycling; ecosystem services –purification of water and air, nutrient cycling, climate control,

Unit 4: Threats to biodiversity (12 lectures)

Natural and anthropogenic disturbances; habitat loss, degradation and fragmentation; climate change; pollution; hunting; over-exploitation; deforestation; hydropower development; invasive species; land use changes; overgrazing; man-wildlife conflicts; consequences of biodiversity loss.

Unit 5: Conservation of biodiversity in India (14 lectures)

In-situ conservation (Biosphere Reserves, National Parks, Wildlife Sanctuaries); *Ex-situ* conservation (botanical gardens, zoological gardens, gene banks, seed banks, pollen culture, tissue culture), role of local communities and traditional knowledge in conservation; biodiversity hotspots; ecological restoration; afforestation; social forestry; agroforestry; joint forest management.

Suggested Readings

1. Gaston, K J. & Spicer, J.I. 1998. Biodiversity: An Introduction. Blackwell Science, London, UK.
2. Krishnamurthy, K.V. 2004. An Advanced Text Book of Biodiversity – Principles and Practices. Oxford and IBH Publications Co. Pvt. Ltd. New Delhi.
3. Pandit, M.K. & Grumbine R.E. 2012. Ongoing and proposed hydropower development in the Himalaya and its impact on terrestrial biodiversity. Conservation Biology 26:1061-1071.
4. Singh, J. S. & Singh, S. P. 1987. Forest vegetation of the Himalaya. The Botanical Review 53: 80 192.
6. Singh, J. S., Singh, S.P. & Gupta, S. 2006. Ecology, Environment and Resource Conservation. Anamaya Publications, New Delhi.
7. Sodhi, N.S. & Ehrlich, P.R. (Eds). 2010. Conservation Biology for All. Oxford University Press.

Discipline Specific Core (DSC-353)
ENERGY AND ENVIRONMENT
Total Marks= 100
End Semester Examination = 70 Internal Examination = 30
Total credits: 4

Unit 1: Energy resources (10 lectures)

Global energy resources; renewable and non-renewable resources: distribution and availability;past, present, and future technologies for capturing and integrating these resources into energy infrastructure; energy-use scenarios in rural and urban setups; energy conservation.

Unit 2: Energy demand (10 lectures)

Global energy demand: current perspective; energy demand and use in domestic, industrial, agriculture and transportation sectors; generation and utilization in rural and urban environments; energy subsidies and environmental costs.

Unit 3: Energy, environment and society (14 lectures)

Impacts of energy use on the environment; fossil fuel use and related issues of air pollution, greenhouse effect, global warming and, urban heat island effect; nuclear energy and radioactive waste disposal, spent fuel; social inequalities related to energy production, distribution, and use.

Unit 4: Energy production and the environment (12 lectures)

Energy production as driver of environmental change; energy production, transformation and utilization associated environmental impacts (Chernobyl and Fukushima nuclear accidents, construction of dams, environmental pollution); energy over-consumption and its impact on the environment, economy, and global change.

Unit 5: Future energy (14 lectures)

Current and future energy use patterns in the world and in India; alternative sources as green energy (biofuels, wind energy, solar energy, geothermal energy; ocean energy; nuclear energy);need for energy efficiency; energy conservation and sustainability.

Suggested Readings

1. McKibben, B. 2012. Global Warming's Terrifying New Math, Rolling Stone Magazine.
2. Craig. J.R., Vaughan, D.J., Skinner. B.J. 1996. Resources of the Earth: Origin, use, and environmental impact (2nd edition). Prentice Hall, New Jersey.
3. Elliott, D. 1997. Sustainable Technology. Energy, Society and Environment (Chapter 3). New York, Routledge Press.
5. Oliver, J. 2013. Dispelling the Myths about Canada's Energy Future, Policy: Canadian Politics and Public Policy, June-July.
6. Mallon, K. 2006. Myths, Pitfalls and Oversights, Renewable Energy Policy and Politics: A Handbook for Decision-Making. EarthScan.

Discipline Specific Core (DSC-354)
GENDER AND ENVIRONMENT, BIODIVERSITY CONSERVATION, ENERGY AND ENVIRONMENT
Total Marks= 100
End Semester Examination = 70 Internal Examination = 30
Total credits: 4
(PRACTICAL)

SECTION-A

1. Survey on the percentage composition of women in commercial establishments and their awareness about environmental pollution with special reference to noise pollution

2. Percentage composition of women in administrative posts/ teaching posts/ private organization and their perception about environmental pollution and its remediation.

3. Perception of urban women homemakers about environmental pollution and its remediation

4. Women as small scale entrepreneurs using local natural resources.

SECTION-B

1. Study of animal diversity measurement.

2. To study the methods of sampling of plant community.

3. To study the selected medicinal plants found in N.E. India

4. Field visit to protected areas (Reserve forest / Wildlife sanctuary etc.)

SECTION-C

1. Demonstration of photovoltaics and solar energy.

2. Biofuel energy resource (Hydrocarbon, Alcohol and Oil) from microorganisms and higher plants.

3. Types of oil and gas and its characterization

4. Renewable energy from biomass and wastes

Discipline Specific Minor (DSM-351)

Total Marks= 100

End Semester Examination = 70 Internal Examination = 30

Total Credits=4

ECOLOGY, ATMOSPHERE AND CLIMATE (PRACTICAL)

SECTION-A

1. To study the allelopathic influence of plant species (Any 1).
2. To prepare a checklist of invasive species.
3. To study the plankton communities in a freshwater ecosystem.
4. To study the distribution of roadside species and investigate the changes in species richness.
5. Field report: Visit to a forest/ river/ wetland ecosystem.

SECTION-B

1. Comparative analysis of maximum-minimum temperature of past 30 years using data obtained from a meteorological station.

2. Study of heat-island effect.

3. Field visit to a nearby meteorological station.

Semester	Course category, marks and credit	Course title	Units
VII	**Discipline Specific Core (DSC-401)** **Total Marks= 100** End Semester Examination= 70 Internal Examination = 30 **Total Credits=4**	**NATURAL HAZARDS AND DISASTER MANAGEMENT**	Natural hazards Anthropogenic hazards Risk and vulnerability assessment Mitigation and preparedness Disaster management in India
	Discipline Specific Core (DSC-402) **Total Marks= 100** End Semester Examination= 70 Internal Examination = 30 **Total Credits=4**	**FOREST ECOLOGY**	Introduction Forest Structure and Composition Forest Dynamics Man and forests Forest Conservation
	Discipline Specific Core (DSC-403) **Total Marks= 100** End Semester Examination= 70 Internal Examination = 30 **Total Credits=4**	**ENVIRONMENTAL LEGISLATION AND POLICY**	History of environmental legislation and policy Environmental legislation Legislative Instruments Case studies International laws and policy
	Discipline Specific Core (DSC-404) **Total Marks= 100** End Semester Examination= 70 Internal Examination = 30 **Total Credits=4**	**FOREST ECOLOGY, DISASTER MANAGEMENT, ENVIRONMENTAL LEGISLATION (PRACTICAL)**	-
	Discipline Specific Minor (DSM-401) **Total Marks= 100** End Semester Examination= 70 Internal Examination = 30 **Total Credits=4**	**DISASTER MANAGEMENT**	Natural hazards Anthropogenic hazards Risk and vulnerability assessment Mitigation and preparedness Disaster management in India

Discipline Specific Core (DSC-401)

Total Marks= 100

End Semester Examination= 70 Internal Examination = 30

Total Credits=4

NATURAL HAZARDS AND DISASTER MANAGEMENT

Unit 1: Natural hazards (12 lectures)

Natural hazards: hydrological, atmospheric and geological hazards; Causes, impacts and mitigation of earthquake, volcanoes, floods, landslides, tsunamis, drought and famine.

Unit 2: Anthropogenic hazards (12 lectures)

Impact of anthropogenic activities such as rapid urbanization, ground water exploitation, sand mining, deforestation, mangroves destruction; flood hazards, deforestation and associated hazards; effects of large scale developmental projects.

Unit 3: Risk and vulnerability assessment (12 lectures)

Two components of risk: likelihood and consequences, qualitative likelihood measurement index; categories of consequences (direct losses, indirect losses, tangible losses, and intangible losses); application of geoinformatics in hazard, risk & vulnerability assessment.

Unit 4: Mitigation and preparedness (14 lectures)

Concept of mitigation; types of mitigation: structural and non-structural mitigation, use of technologies in mitigations such as barrier, deflection and retention systems; concept of preparedness; importance of planning, exercise, and training in preparedness; role of public, education and media in hazard preparedness.

Unit 5: Disaster management in India (10 lectures)

National Disaster Management Framework, national response mechanism, role of government bodies such as NDMC and IMD; role of armed forces and media in disaster management; role of space technology in disaster management.

Suggested Readings:-

1. Coppola D. P. 2007. Introduction to International Disaster Management. Butterworth Heinemann.
2. Cutter, S.L. 2012. Hazards Vulnerability and Environmental Justice. Earth Scan, Routledge Press.
3. Keller, E. A. 1996. Introduction to Environmental Geology. Prentice Hall, Upper Saddle River, New Jersey.
4. Schneid, T.D. & Collins, L. 2001. Disaster Management and Preparedness. Lewis Publishers, New York, NY.
5. Pine, J.C. 2009. Natural Hazards Analysis: Reducing the Impact of Disasters. CRC Press, Taylor and Francis Group.
6. Smith, K. 2001. Environmental Hazards: Assessing Risk and Reducing Disaster. Routledge Press.
7. Wallace, J.M. & Hobbs, P.V. 1977. Atmospheric Science: An Introductory Survey. Academic Press, New York.

Discipline Specific Core (DSC-402)
Total Marks= 100
End Semester Examination= 70 Internal Examination = 30
Total Credits=4
FOREST ECOLOGY

Unit 1: Introduction (12 lectures)

Forest Ecology: definition and concept; forest ecosystems, significance of forest and its resources, Forest types of India; Urban forests: concept and significance

Unit 2: Forest Structure and Composition (12 lectures)

Introduction; Concepts of forest structure and function; Biodiversity of Indian forests: alpine, sub tropical, tropical; Forest physiognomy, Forest Structure and its significance, forest stratification.

Unit 3: Forest Dynamics (12 lectures)

Introduction; Nutrient cycling in forest ecosystems; Litter fall in forest ecosystems: types of litter, factors affecting forest litter, significance of forest litter; Forest hydrology concept and significance; Forest Succession.

Unit 4: Man and forests (10 lectures)

Introduction; Forest disturbance: fire, flood, grazing, invasive species; Deforestation: causes and mitigation; pest and diseases of forests; traditional vs commercial use of forests, NTFPs

Unit 5: Forest Conservation (10 lectures)

Introduction; Approaches to forest conservation: protected areas, sustainable forest management, forest restoration; Forest laws: Indian Forest Act, Forest Rights Act, Forest Conservation Act, Joint Forest Management.

Readings:

Kashian Daniel M., Zak Donald R., Barnes Barton V. and Spurr Stephen H. (eds) (2023) Forest Ecology 5th edition ISBN: 978-1-119-47614-6

Champion, H.G. and Seth, S.K. (1968) A Revised Survey of the Forest Types of India. Natraj Publishers, Dehradun (Reprinted 2004)

Kimmins, J.P. (2004) Forest Ecology (2nd edn.). Pearson Education

Raymond, Y.A. and Ronald G.L. (2003) Introduction to Forest Ecosystem Science and Management (3rd ed) John Wiley and sons

Discipline Specific Core (DSC-403)

Total Marks-100

End Semester Examination= 70 Internal Examination = 30

Total Credits-4

ENVIRONMENTAL LEGISLATION AND POLICY

Unit 1: History of environmental legislation and policy (12 lectures)
Ancient period: Mauryan period, Medieval period British India, Independent India: Van Mahotsava 1950, National Forest Policy 1952, Orissa River pollution and prevention Act 1953. Constitution of India: environment related areas. National green tribunal

Unit 2: Environmental legislation (12 lectures) Legal definitions (environmental pollution, natural resource, biodiversity, forest, sustainable development);Article 48A(The protection and improvement of environment and safeguarding of forests and wildlife); Article 51 A (Fundamental duties).

Unit 3: Legislative Instruments (12 lectures) The Wildlife (Protection) Act 1972; The Environment (Protection) Act 1986; The Biological Diversity Act 2002; scheme and labeling of environment friendly products, Ecomarks.

Unit 4: Case studies (12 lectures)

National Green Tribunal: Aditya N Prasad vs. Union of India & Others; Ganga Tanneries Case:

M.C. Mehta vs. Union of India 1988; environmental education case: M.C. Mehta vs. Union of India, WP 860/1991.

Unit 5: International laws and policy (12 lectures)
Stockholm Conference 1972; United Nations Conference on Environment and Development 1992; Rio de Janeiro (Rio Declaration, Agenda 21); Montreal Protocol 1987; Kyoto Protocol 1997; Copenhagen and Paris summits; Ramsar Convention.

Suggested Readings

1. Abraham, C.M.1999. Environmental Juris prudence in India. Kluwer Law International.

2. Agarwal, V.K. 2005. Environmental Laws in India: Challenges for Enforcement. Bulletin of the National Institute of Ecology 15: 227-238.

3. Divan, S. & Rosencranz, A. 2001.Environmental Law and Policy in India. Oxford University Press.

4. Divan, S. & Rosencranz, A. 2002. Environmental Law and Policy in India: Cases, Materials and Statutes (2nd edition). Oxford University Press.

5. Gupta, K.R.2006. Environmental Legislation in India. Atlantic Publishers and Distributors.

6. Leelakrishnan, P. 2008.Environmental Law in India (3rdedition). Lexis Nexis India.

7. Naseem, M. 2011. Environmental Law in India Mohammad. Kluwer Law International

Discipline Specific Core (DSC-404)
Total Marks= 100
End Semester Examination= 70 Internal Examination = 30
Total credits: 4
FOREST ECOLOGY, DISASTER MANAGEMENT, ENVIRONMENTAL LEGISLATION (PRACTICAL)

SECTION-A

1. Determination of minimum size of the quadrat by the 'species-area-curve' method.
2. Determination of frequency of species by line transect method.
3. To study the rhizome characteristics of bamboos.

SECTION-B

1. Studies on any natural hazard that took place in recent past and its impact on the landscape and population.
2. Recording of meteorological data (Maximum and minimum temperature, morning and afternoon humidity, sunshine hours, rainfall etc) of any area for the past 15 days (minimum three parameters are to be studied).
3. Visit any nearby industrial area and assessment of hazard coming out from the industrial discharges.
4. To prepare a project report on any natural disaster that took place in the locality in the past and obtain people's perspectives on the disaster.

SECTION-C

1. Report on pollution control measures adopted by Assam State Pollution Control Board office, Silchar.
2. Analysis of selected case studies on environmental litigation
3. To prepare Peoples Biodiversity Register of any locality

Discipline Specific Minor (DSM-401)
Total Marks= 100
End Semester Examination= 70 Internal Examination = 30
Total Credits=4
DISASTER MANAGEMENT

Unit 1: Natural hazards and disasters (12 lectures)
Natural hazards: hydrological, atmospheric, and geological hazards; Causes, impacts, and mitigation of earthquakes, volcanoes, floods, landslides, tsunamis, drought, and famine.

Unit 2: Anthropogenic hazards (12 lectures)
Impact of anthropogenic activities such as rapid urbanization, groundwater exploitation, sand mining, deforestation, destruction of mangroves; developmental projects.

Unit 3: Risk and vulnerability assessment (14 lectures)
Two components of risk: likelihood and consequences, qualitative likelihood measurement index; categories of consequences (direct losses, indirect losses, tangible losses, and intangible losses); application of geoinformatics in hazard, risk & vulnerability assessment.

Unit 4: Mitigation and preparedness (14 lectures)
Concept of mitigation; types of mitigation: structural and non-structural mitigation, use of technologies in mitigation such as barrier, deflection, and retention systems; concept and training in preparedness; role of public, education and media in hazard preparedness.

Unit 5: Disaster management in India (14 lectures)
National Disaster Management Framework, national response mechanism, role of government bodies such as NDMC and IMD; role of armed forces and media in disaster management; role of space technology in disaster management.

Suggested Readings:-

1. Coppola D. P. 2007. Introduction to International Disaster Management. Butterworth Heinemann.
2. Cutter, S.L. 2012. Hazards Vulnerability and Environmental Justice. EarthScan, Routledge Press.
3. Keller, E. A. 1996. Introduction to Environmental Geology. Prentice Hall, Upper Saddle River, New Jersey.
4. Schneid, T.D. & Collins, L. 2001. Disaster Management and Preparedness. Lewis Publishers, New York, NY.
5. Pine, J.C. 2009. Natural Hazards Analysis: Reducing the Impact of Disasters. CRC Press, Taylor and Francis Group.
6. Smith, K. 2001. Environmental Hazards: Assessing Risk and Reducing Disaster. Routledge Press.
7. Wallace, J.M. & Hobbs, P.V. 1977. Atmospheric Science: An Introductory Survey. Academic Press, New York.

Semester	Course category, marks and credit	Course title	Units
VIII		**DEGREE WITH HONOURS AND RESEARCH**	
	Discipline Specific Core (DSC-451) **Total Marks= 100** End Semester Examination= 70 Internal Examination = 30 **Total Credits=4**	**NATURAL RESOURCE MANAGEMENT AND SUSTAINABILITY**	Natural resources and conservation Mineral resources Non-renewable energy resources Renewable energy resources Resource management
	Discipline Specific Minor (DSM-451) **Total Marks= 100** End Semester Examination= 70 Internal Examination = 30 **Total Credits=4**	**NATURAL HAZARDS**	Natural hazards Anthropogenic hazards Risk and vulnerability assessment Mitigation and preparedness Disaster management in India
		RESEARCH PROJECT/ DISSERTATION (CREDITS: 4+4+4=12)	
		DEGREE WITH HONOURS	
	Discipline Specific Core (DSC-451) **Total Marks= 100** End Semester Examination= 70 Internal Examination = 30 **Total Credits=4**	**NATURAL RESOURCE MANAGEMENT AND SUSTAINABILITY**	Natural resources and conservation Mineral resources Non-renewable energy resources Renewable energy resources Resource management
	Discipline Specific Core (DSC-452) **Total Marks= 100** End Semester Examination= 70 Internal Examination = 30 **Total Credits=4**	**ENVIRONMENTAL POLLUTION**	Air pollution Water pollution Soil pollution Noise pollution Radioactive pollution, thermal pollution and E-pollution

	Discipline Specific Core (DSC-453) **Total Marks= 100** End Semester Examination= 70 Internal Examination = 30 **Total Credits=4**	**HORTICULTURE AND ITS MANAGEMENT**	Introduction to horticulture Propagation of horticultural plants Production technology of horticultural crops Post-harvest technology and management Protected cultivation and urban horticulture
	Discipline Specific Core (DSC-454) **Total Marks= 100** End Semester Examination= 70 Internal Examination = 30 **Total Credits=4**	**SOLID WASTE MANAGEMENT**	Effect of solid waste disposal on environment Solid Waste Management Industrial waste management Resource Recovery Policies for solid waste management
	Discipline Specific Minor (DSM-451) **Total Marks= 100** End Semester Examination= 70 Internal Examination = 30 **Total Credits=4**	**NATURAL HAZARDS**	Natural hazards Anthropogenic hazards Risk and vulnerability assessment Mitigation and preparedness Disaster management in India

SYLLABUS FOR DEGREE WITH HONOURS AND RESEARCH
Discipline Specific Core (DSC-451)
Total Marks= 100
End Semester Examination= 70 Internal Examination = 30
Total Credits=4
NATURAL RESOURCE MANAGEMENT AND SUSTAINABILITY

Unit 1: Natural resources and conservation (12 lectures)
Forest resources: economic and ecological importance of forests, forest management strategies, sustainable forestry; water resources: supply, renewal, and use of water resources, freshwater shortages, strategies of water conservation; soil resources: importance of soil, soil conservation strategies;

Unit 2: Mineral resources (12 lectures)
Mineral resources and the rock cycle; identified resources; undiscovered resources; reserves; types of mining: surface, subsurface, open-pit, dredging, strip; reserve-to-production ratio; ocean mining for mineral resources; environmental effects of extracting and using mineral resources.

Unit 3: Non-renewable energy resources (12 lectures)
Oil: formation, exploration, extraction and processing; natural gas: exploration, coal: extraction, processing, environmental impacts of non renewable energy consumption;

Unit 4: Renewable energy resources (12 lectures)
Energy efficiency; solar energy hydropower, nuclear power, tidal energy, wave energy, ocean thermal energy conversion (OTEC); geothermal energy; energy from biomass; bio-diesel.

Unit 5: Resource management (12 lectures)
Approaches in resource management: ecological approach; economic approach; ethnological approach; implications of the approaches; integrated resource management strategies; concept of sustainability science: different approach towards sustainable development and its different constituents;

Suggested Readings
1. Craig, J.R., Vaughan. D.J. & Skinner. B.J. 1996. Resources of the Earth: Origin, Use, and Environmental Impacts (2ndedition). Prentice Hall, New Jersey.
2. Freeman, A.M. 2001. Measures of value and Resources: Resources for the Future. Washington DC.
3. Freeman, A.M. 2003. Millennium Ecosystem Assessment: Conceptual Framework. Island Press.
4. Ginley, D.S. & Cahen, D. 2011. Fundamentals of Materials for Energy and Environmental Sustainability. Cambridge University Press.
5. Klee, G.A. 1991. Conservation of Natural Resources. Prentice Hall Publication.
6. Miller, T.G. 2012. Environmental Science. Wadsworth Publishing Co.
7. Owen, O.S, Chiras, D.D, &Reganold, J.P. 1998. Natural Resource Conservation – Management for Sustainable Future (7thedition). Prentice Hall.
8. Ramade, F. 1984. Ecology of Natural Resources. John Wiley & Sons Ltd.
9. Tiwari, G.N. & Ghosal. M. K. 2005. Renewable Energy Resources: Basic Principles and Application. Narosa Publishing House.

Discipline Specific Minor (DSM-451)

Total Marks= 100

End Semester Examination= 70 Internal Examination = 30

Total Credits=4

NATURAL HAZARDS

Unit 1: Natural hazards (12 lectures)

Natural hazards: hydrological, atmospheric and geological hazards; Causes, impacts and mitigation of earthquakes, volcanoes, floods, landslides, tsunamis, drought and famine.

Unit 2: Anthropogenic hazards (12 lectures)

Impact of anthropogenic activities such as rapid urbanization, ground water exploitation, sand mining, deforestation, mangroves destruction; flood hazards, deforestation and associated hazards; effects of large scale developmental projects.

Unit 3: Risk and vulnerability assessment (14 lectures)

Two components of risk: likelihood and consequences, qualitative likelihood measurement index; categories of consequences (direct losses, indirect losses, tangible losses, and intangible losses); application of geoinformatics in hazard, risk & vulnerability assessment.

Unit 4: Mitigation and preparedness (12 lectures)

Concept of mitigation; types of mitigation: structural and non-structural mitigation, use of technologies in mitigations such as barrier, deflection and retention systems; concept and training in preparedness; role of public, education and media in hazard preparedness.

Unit 5: Disaster management in India (10 lectures)

National Disaster Management Framework, national response mechanism, role of government bodies such as NDMC and IMD; role of armed forces and media in disaster management; role of space technology in disaster management.

Suggested Readings: -

1. Coppola D. P. 2007. Introduction to International Disaster Management. Butterworth Heinemann.
2. Cutter, S.L. 2012. Hazards, Vulnerability and Environmental Justice. Earth Scan, Routledge Press.
3. Keller, E. A. 1996. Introduction to Environmental Geology. Prentice Hall, Upper Saddle River, New Jersey.
4. Schneid, T.D. & Collins, L. 2001. Disaster Management and Preparedness. Lewis Publishers, New York, NY.
5. Pine, J.C. 2009. Natural Hazards Analysis: Reducing the Impact of Disasters. CRC Press, Taylor and Francis Group.
6. Smith, K. 2001. Environmental Hazards: Assessing Risk and Reducing Disaster. Routledge Press.
7. Wallace, J.M. & Hobbs, P.V. 1977. Atmospheric Science: An Introductory Survey. Academic Press, New York.

RESEARCH PROJECT/ DISSERTATION (CREDITS: 4+4+4=12)

SYLLABUS FOR DEGREE WITH HONOURS

Discipline Specific Core (DSC-451)

Total Marks= 100

End Semester Examination= 70 Internal Examination = 30

Total Credits=4

NATURAL RESOURCE MANAGEMENT AND SUSTAINABILITY

(*Syllabus provided earlier*)

Discipline Specific Core (DSC-452)

Total Marks= 100

End Semester Examination= 70 Internal Examination = 30

Total Credits=4

ENVIRONMENTAL POLLUTION

Unit 1: Air pollution (12 lectures)

Ambient air quality: monitoring and standards (National Ambient Air Quality Standards of India); air quality index; sources and types of pollutants (primary and secondary); smog (case study); effects of different pollutants on human health (NOx, SOx, PM, CO, CO2, hydrocarbons and VOCs) and control measures; indoor air pollution: sources and effects on human health; affects of air pollution on atmospheric processes;

Unit 2: Water pollution (12 lectures)

Sources of surface water (river, pond, lake and marine) and ground water pollution; water quality parameters and standards; organic waste and water pollution; water pollution and plastic; eutrophication; COD, BOD, DO; effect of water contaminants on human health

Unit 3: Soil pollution (6 lectures)

Causes of soil pollution and degradation; Soil Degradation in North East India, soil pollution and plastic, effect of soil pollution on environment, control strategies.

Unit 4: Noise pollution (8 lectures)

Noise pollution: source, intensity and permissible ambient noise levels; effect on communication, impacts on life forms and humans - working efficiency, physical and mental health; control measures,

Unit 5: Radioactive pollution, thermal pollution and E-pollution (8 lectures)

Radioactive material and sources of radioactive pollution; effect of radiation on human health (somatic and genetic effects); thermal pollution- causes and its effects**;** E-pollution- causes and its effects.

Suggested Readings

1. Gurjar, B.R., Molina, L.T. & Ojha C.S.P. 2010. Air Pollution: Health and Environmental Impacts. CRC Press, Taylor & Francis.

2. Hester, R.E. & Harrison, R.M. 1998. Air Pollution and Health. The Royal Society of Chemistry, UK.

3. Park, K. 2015. Park's Textbook of Preventive and Social Medicine (23rdedition). Banarsi das Bhanot Publishers.

4. Pepper, I.L., Gerba, C.P. & Brusseau, M.L. 2006. Environmental and Pollution Science. Elsevier Academic Press.

5. Purohit, S.S. & Ranjan, R. 2007. Ecology, Environment & Pollution. Agrobios Publications.

6. Vesilind, P.J., Peirce, J.J., & Weiner R.F. 1990. Environmental Pollution and Control. Butterworth-Heinemann, USA.

Discipline Specific Core (DSC-453)

Total Marks= 100

End Semester Examination= 70 Internal Examination = 30

Total Credits=4

Horticulture and its management

Unit 1: Introduction to horticulture: (12 lectures)

Horticulture: Meaning, importance, and branches; Significance of horticulture in Indian and global context. Horticultural Classification: Fruits, vegetables, ornamental plants, medicinal and aromatic plants. Climatic Zones and Horticulture Crops: Agro-climatic regions of India, Crops suitable for different zones.

Unit 2: Propagation of horticultural plants: (12 lectures)

Propagation Methods: Sexual propagation: Seed selection, treatment, and sowing, Asexual propagation: Cuttings, grafting, budding, and layering techniques. Nursery Management: Importance of nursery. Establishment and management of horticultural nurseries. Modern Techniques: Micro-propagation: Tissue culture basics, Use of bio-fertilizers and growth regulators.

Unit 3: Production technology of horticultural crops: (12 lectures)

Fruit Crops: Cultivation practices for citrus, banana, jackfruit, pineapple and plantation crops. Vegetable Crops: Production techniques for chili, brinjal, cucurbits etc. Ornamental and Flower Crops: Cultivation of marigold, orchids, and other underutilized local fruits. Plant Protection: Common pests and diseases, their control measures.

Unit 4: Post-harvest technology and management: (12 lectures)

Post-Harvest Losses: Causes and strategies to minimize losses. Storage Methods: Cold storage, controlled atmosphere storage, and traditional methods Value Addition: Processing of fruits and vegetables. Preparation of juices, jams, pickles, and dried products.

Unit 5: Protected cultivation and urban horticulture: (12 lectures)

Protected Cultivation: Importance and types: Greenhouse, polyhouse, and shade net. Urban Horticulture: Terrace gardening, vertical gardening, and hydroponics. Environmental Benefits: Role of horticulture in improving soil and air quality and urban aesthetics.

Selected Readings:

1. Chadha, K. L. (2001). *Handbook of Horticulture*. Indian Council of Agricultural Research (ICAR), New Delhi.
2. Kumar, N. (2015). *Introduction to Horticulture* (6th Edition). Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
3. Prasad, S. and Kumar, U. (2014) *Principles of Horticulture and Fruit Production*. Agrobios (India), Jodhpur
4. Singh, Jitendra (2014). *Basic Horticulture* (2nd Edition). Kalyani Publishers, Ludhiana.
5. Sharma, V. K. (2018). *Horticulture Principles and Practices*. Kalyani Publishers, Ludhiana.

Discipline Specific Core (DSC-454)

Total Marks-100

End Semester Examination= 70 Internal Examination = 30

Total Credits-4

SOLID WASTE MANAGEMENT

Unit 1: Effect of solid waste disposal on environment (12 lectures)

Impact of solid waste on environment, human and plant health; effect of solid waste and industrial effluent discharge on water quality and aquatic life; mining waste and land degradation; effect of land fill leachate on soil characteristics and ground water pollution.

Unit 2: Solid Waste Management (12 lectures)

Different techniques used in collection, storage, transportation, and disposal of solid waste (municipal, hazardous, and biomedical waste); landfill (traditional and sanitary landfill design); thermal treatment (pyrolysis and incineration) of waste material; drawbacks in waste management techniques

Unit 3: Industrial waste management (12 lectures)

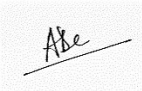
Types of industrial waste: hazardous and non-hazardous; effect of industrial waste on air, water and soil; industrial waste management and its importance; stack emission control and emission monitoring; effluent treatment plant and sewage treatment plant.

Unit 4: Resource Recovery (12 lectures)

4R- reduce, reuse, recycle and recover; biological processing - composting, anaerobic digestion, aerobic treatment; reductive dehalogenation; mechanical biological treatment; green techniques for waste treatment; waste- to- energy (WTE): refuse derived fuel (RDF); different WTE processes: combustion, pyrolysis, landfill gas (LFG) recovery; anaerobic digestion; gasification.

Unit 5: Policies for solid waste management (12 lectures)

Municipal Solid Wastes (Management and Handling) Rules 2000; Hazardous Wastes Management and Handling Rules 1989; Bio-Medical Waste (Management and Handling) Rules 1998; Eco-friendly or green products



Suggested Readings

1. Asnani, P.U. 2006. Solid waste management. India Infrastructure Report 570.

2. Bagchi, A. 2004. Design of Landfills and Integrated Solid Waste Management. John Wiley& Sons.

3. Blackman, W.C. 2001. Basic Hazardous Waste Management. CRC Press.

4. Mc Dougall, F.R., White, P.R., Franke, M., & Hindle, P. 2008. Integrated Solid Waste Management: A Life Cycle Inventory. John Wiley & Sons.

5. USEPA.1999. Guide for Industrial Waste Management. Washington D.C.

6. White, P.R., Franke, M. & Hindle P. 1995. Integrated Solid waste Management: A Lifecycle Inventory. Blackie Academic & Professionals.

7. Zhu, D., Asnani, P.U., Zurbrugg, C., Anapolsky, S. & Mani, S. 2008. Improving Municipal Solid waste Management in India. The World Bank, Washington D.C.

Discipline Specific Minor (DSM-451)

Total Marks= 100

End Semester Examination= 70 Internal Examination = 30

Total Credits=4

NATURAL HAZARDS

(Syllabus provided earlier)